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Flora of Australia - Volume 28
Gentianales

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This volume deals with four families of the Order of Gentianales in Australia: Loganiaceae, Gentianaceae, Apocynaceae and Asclepiadaceae, and provides descriptions of 62 genera and 326 species in these families.

Loganiaceae are a mainly tropical and subtropical family. In Australia there are 9 genera and 100 species, but the majority of species are found in 2 genera, *Logania* (33 species) and *Mitrasacme* (48 species). Two newly described genera, segregated from *Mitrasacme*, are included in this treatment.(Contributors B.J. Conn, E.A. Brown, C.R. Dunlop)

The Australian Gentianaceae consist of 8 genera and 31 species. The montaine taxa have, until recently, been included in *Gentianella*, but here they are distributed between *Gentiana* and *Chionogentias*.(Contributor L. G. Adams).

Apocynaceae are also pantropical, with 22 genera and 87 species in Australia. The family contains a large number of ornamental species that are extensively cultivated in tropical and subtropical regions. many species have toxic fruit and foliage, and some species are important as a source of alkaloids in medical research.(Contributors P.I. Forster, J.B. Williams).

Asclepoadaceae are a pantropical family, perhaps best know for their very specialised floral structure, and many, including *Hoya, Asclepias* and *Dischidia,* are grown as horticultural subjects. Australia has 23 genera and 98 species.(Contributors P.I. Forster, D.J. Liddle, A Nicholas)

The discussion of the families includes an introduction, literary references, keys to genera, followed by a species key and description of species. In addition there are 64 colour photos and numerous black and white illustrations highlighting characteristics of the various species, while distribution maps are included at the end of the book.

Thank you

The editors wish to thank Ian Endersby for his stimulating series of articles written while he was our 'Naturalist in Residence'. Ian's wide experience and knowledge showed in the very diverse subjects he covered.

Special Issues

This year we will publish two special issues of *The Victorian Naturalist* in addition to our normal six issues.

These 'specials' will be part of the centenary celebrations of Wilsons Promontory and Mount Buffalo as national parks.

We are still in need of articles and notes from our members, especially anything on the natural history of Mt Buffalo.

Reminder

Annual subscriptions for 1998 are due. We urge you to renew your membership so that you will continue to receive *The Victorian Naturalist*.

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Cover: The leaf beetle *Pyrgoides orphana* (see article p. 27). Drawing by Erich Sacco.

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Notes on the Biology of Some Hesperiidae and Lycaenidae (Lepidoptera) in South-eastern Australia

M.F. Braby[1]

Abstract

New larval food plants are listed for *Toxidia doubledayi* (C. Felder), *Taractrocera papyria* (Boisduval), *Hypochrysops delicia* Hewitson, *Candalides absimilis* (Felder), *Neolucia agricola* (Westwood) and *Nacaduba biocellata* (C.& R. Felder) from southern New South Wales, the Australian Capital Territory and Victoria. Notes are provided on the life cycle of *Netrocoryne repanda* (C.& R. Felder), *T. doubledayi, Herimosa albovenata* (Waterhouse), and *N. agricola*, and additional comments made on the behaviour and biology of *Trapezites symmomus* (Hubner), *Acrodipsas myrmecophila* Waterhouse and Lyell and *Jalmenus evagoras* (Donovan).

(*The Victorian Naturalist* **115**, 1998, 4-8)

Introduction

The following notes relate to the natural history and general biology of five species of skippers (Hesperiidae), and five species of blues (Lycaenidae) from south-eastern Australia. Observations on the biology and behaviour of the early stages of these butterflies were made during 1989-97 between Port Macquarie, New South Wales, and near Melbourne, including the Australian Capital Territory. New food plant records are in addition to those listed by Common and Waterhouse (1981) and Dunn and Dunn (1991). Nomenclature follows Atkins and Edwards (1996) and Edwards (1996).

Hesperiidae

Netrocoryne repanda (C.& R. Felder)

In the Australian Capital Territory adults of this predominantly tropical and subtropical species are present for only a few months, from January to March (Kitching *et al.* 1978). During 1994-95 a search for the early stages was made on Kurrajong *Brachychiton populneus* R. Br. (Sterculiaceae), its larval food plant in the Australian Capital Territory (Atkins 1984), to determine how *N. repanda* survives the harsh winter period when daily temperatures typically fall below 13° C The average maximum temperatures for June, July and August are 12.0°, 11.0° and 12.8° C respectively (Bureau of Meteorology).

At Tuggeranong Hill, on 31 July 1994, a number of larvae were found inside shelters on the food plant. The larvae, all very small in size and possibly in their second instar (Fig. 1), remained hidden inside the shelters that had been constructed by the first instars after emergence from the eggs. The first instar shelter is made by cutting a 1–cm–wide disc from a leaf, which is folded over and attached to the upper surface with silk (Waterhouse 1934). There were no signs of the leaves having being eaten recently and the larvae appeared to be in a state of quiescence, possibly having been in this state for several months. Four larvae were brought into captivity and reared on fresh leaves of *B. populneus* at 20–22°C. They immediately started to make new shelters and commenced feeding. Two were parasitised by Hymenoptera but the other two pupated in October and November. On a subsequent visit to Tuggeranong Hill, on 20 November 1994, four more larvae were collected, all in their late instars, but all later proved to be parasitised.

The following season I revisited the site on 26 August 1995 to confirm my observations of the previous year: on this occasion

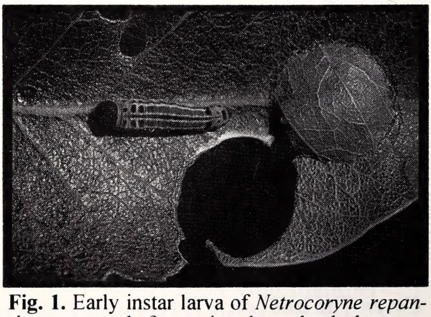

Fig. 1. Early instar larva of *Netrocoryne repanda* removed from its larval shelter on *Brachychiton populneus*, Tuggeranong Hill, ACT, 31 July 1994. Photo: M.F. Braby.

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seven larvae were found on four trees. Again all larvae were small (less than 8 mm long) and appeared to be only in their second instar. As in the previous season these larvae remained hidden inside the circular shelters, constructed after hatching, and there were no signs of the adjacent leaves having been freshly eaten. No advanced shelters or larger larvae were found although numerous empty pupal shelters were in evidence from the previous year. These observations indicate that at the southern end of its range *N. repanda* overwinters as larvae in the early instars.

***Trapezites symmomus* (Hübner)**

A female was observed to lay two eggs on the food plant Spiny-headed Matrush *Lomandra longifolia* Labill. (Xanthorrhoeaceae), at Port Macquarie, New South Wales, on 23 March 1994 around 12.30 pm E.S.T. One egg was deposited on a dead (brown) leaf, the other was laid on a dead flower spike. The eggs were laid on separate tussocks growing about eight metres apart. Oviposition on this food plant appears to be uncommon in the species (Braby 1993), and these observations are consistent with previous reports that *T. symmomus* rarely lays on fresh, green leaves of *L. longifolia.*

***Toxidia doubledayi* (C. Felder)**

This species has recently invaded the outer north-eastern suburbs of Melbourne (Braby 1994). At Eltham, I first recorded adults in numbers during the 1993-94 season and since that time it has been present each Christmas, being locally common during the 1994-95, 1995-96 and 1996-97 seasons, suggesting that a resident breeding population is now well established.

On 31 December 1994, I observed a female examining leaf litter for suitable oviposition sites: after careful searching she eventually laid a single egg on the petiole of a dead eucalypt leaf litter near some Weeping Grass *Microlaena stipoides* (Labill.) R.Br. (Poaceae), at 3.54 pm E.S.T. Further eggs were obtained by caging females over potted *M. stipoides.* All eggs hatched 11 days later and the larvae accepted and completed development on potted clumps of this grass. The early instar larva was observed to make a shelter by rolling part of a fresh leaf of the grass. This was achieved by first attaching a strong transverse silken thread to the upperside. Several more transverse threads were then attached between the edges of the leaf, and as the threads dried and hardened the margins were drawn together. The edges of the leaf were then joined with silk from the outside, forming a small cylindrical tube about one centimetre long in which the larva retreated with the head oriented towards the leaf base. The larva emerged at night to feed on the lower sections of the leaf. The next shelter was formed by folding over the apical portion of a leaf through 180^{o} and securing the edges with silk. In the late instars, however, the larva constructed a larger shelter in the leaf litter on the ground at or near the base of the food plant, often by rolling the edges of a dead eucalypt leaf with silk. As in the early instars the larva remained hidden during the day in the shelter, emerging at night to feed on the leaves. The larvae developed slowly during late summer, autumn, winter and spring, emerging as adults the following November and December, indicating that there is a single generation annually near Melbourne.

***Herimosa albovenata* (Waterhouse)**

In New South Wales, this univoltine species is known only from three localities: the Gunnedah district, Mount Kaputar, and the Bredbo district (Dunn and Dunn 1991; Atkins 1994). Fisher (1978) and Atkins (1994) described and illustrated the early stages but the life cycle has not been studied closely. The following notes are based on observations made at a grassland site between Bredbo and Cooma during 1994-95 and 1997. Adults were on the wing for a very limited period, from early October to early November (latest record two males 4 November 1995).

A female was observed to deposit a single egg on a dry dead leaf of Speargrass *Austrostipa scabra* (Lindley) (Poaceae), on 29 October 1994 at 12.30 pm E.S.T. Before laying she hovered over the food plant and then descended slowly to settle on a leaf. A further four eggs were found and collected on nearby tussocks of this plant, all eggs having being deposited singly on dead brown leaves. The larvae from these eggs emerged 11–17 days later and one was

reared on a tussock of potted *Austrostipa*.

On 30 April 1995 I revisited the site and two larvae were collected from within their shelters, each near the base of a tussock of the food plant (Fig. 2). These larvae were in their final instar and had a slightly 'hunched' posture. When placed on thepotted tussock with the other larva they built new shelters. However, they did not feed and remained hunched within their shelters during May and the succeeding winter months. The three larvae did not resume feeding and by early September they had pupated. Two of these pupae unfortunately perished but one survived with the adult emerging on 24 October 1995.

On 22 June 1997, I revisited the site and located two larvae on separate plants in shelters near the base of the food plant. Again both larvae were in their final instar and in a hunched dormant state. These observations suggest that the larvae develop rapidly during late spring and summer and then remain dormant (possibly in diapause) in the final instar throughout autumn and winter. Frosts are very frequent in the area; at Cooma, for example, there is an average of 105 frosts per year, with 82% of these occurring between May and September (Bureau of Meteorology). Severe low temperatures may constrain larval growth and development during this period.

Fig. 2. Final instar larva of *Herimosa albovenata* removed from its larval shelter on *Austrostipa scabra*, near Bredbo, NSW, 22 June 1997. Photo: M.F. Braby.

***Taractrocera papyria* (Boisduval)**

A single pupa was collected from within its shelter deep within a large tussock of Spear-grass, *Austrostipa scabra* (Poaceae), near Bredbo, New South Wales, on 29 October 1994. No other conspicuous grasses grew in the immediate vicinity of the tussock from which the pupa was collected and it was very likely the larva had fed on this particular grass. The adult emerged two weeks later. *A. scabra* has not previously been listed as a larval food plant for *T. papyria.*

Lycaenidae

***Acrodipsas myrmecophila* (Waterhouse and Lyell)**

At Pigeon House Mountain, 20 km west of Ulladulla, New South Wales, a pair was collected in copulation after the male was observed to court the female on the summit (720 m) at 1.20 pm E.S.T., 9 December 1995. The female, in fresh condition, was observed first as she fluttered slowly above the canopy of the tallest eucalypt. She was quickly approached by a male, in worn condition. The pair flew closely together but briefly before they settled on the outer foliage of the eucalypt, about eight metres from ground level. The female settled first followed by the male. Soon after she landed she opened her wings at about 90^{o} towards the sun, and the male settled near her and at once proceeded to mate. Once the pair had successfully coupled she closed her wings.

The pair remained perched on a leaf of the tree and were observed with 10x25 binoculars for more than 10 mins. before I decided to capture them for positive identification. Courtship behaviour in this species is similar to that of *A. brisbanensis* (Miskin) (F. Douglas *pers. comm.*) in which courtship appears to be relatively simple, the male apparently spending little time and effort with the female prior to copulation. Pigeon House represents a new locality for this rare lycaenid.

***Hypochrysops delicia* Hewitson**

A colony was discovered breeding on Silver Wattle *Acacia dealbata* Link

(Mimosaceae), along the Diamond Creek at Eltham Lower Park, Eltham, Victoria, on 2–3 January 1997. The larval food plant grew as several healthy trees in a small flat grassy area immediately adjacent to the creek. A cluster of 23 eggs was located in a crack on the trunk, about 0.6 m from the ground, of one large tree; another cluster of about 40 eggs was found deposited in a scar on a thin branch (c. 15 mm wide) in the canopy of another large tree (c. 7 m high). An empty pupal shell was also recovered from a small hollow dead branch of a third tree. Most of the eggs later proved to be parasitised. Ants of the genus *Crematogaster* were common on all trees.

Adult butterflies were very common in the area, and three females were netted during mid afternoon (c. 3.00 pm E.S.T.) as they settled on branches near the tops of the trees. Males were relatively common, circling the tops of the host trees in the late afternoon sun; they frequently settled on particular outermost branches and were competing among one another for perch sites, behaviour similar to that when hilltopping. Females, after settling on a tree, were noted to spend considerable time walking slowly along the branches trailing the abdomen, presumably searching for suitable oviposition sites. *A dealbata* has not previously been listed as a larval food plant.

***Jalmenus evagoras* (Donovan)**

The early stages of *J. evagoras* are generally found on young trees of *Acacia*, typically less than 1.5 m high, the preference for relatively small plants apparently being determined by the foraging (vertical) distribution of the attendant ant and female oviposition behaviour (Smiley et al. 1988). Occasionally, however, colonies of the butterfly may be found on mature trees in excess of six metres (Braby 1988).

On 28 December 1989 the early stages of *J. evagoras* were discovered on a large tree of Blackwood, *Acacia melanoxylon* R. Br. (Mimosaceae), at Toorourong Reservoir, Whittlesea, Victoria. The estimated tree height was six to seven metres and some 250 to 500 larvae, pupae and adults were present (an unforgettable sight!). The attendant ant was a smaller species of *Iridomyrmex* (Det. S. Shattuck) compared to the ant species that usually attends the early stages of *J. evagoras* in the outer Melbourne area (*pers. obs.*).

The colony was still extant and thriving during subsequent visits on 30 December 1991, 3 January 1993 and 26 December 1995. However, on 24 December 1996, very few individuals were present, perhaps no more than 10 late instar larvae and pupae. Adjacent, smaller trees, however, had been colonised by the butterfly in considerably higher numbers. These observations indicate that a particular host tree may be utilised by *J. evagoras* for at least seven years. However, judging by the high numbers of immatures recorded in 1989, it is possible that the tree had been used for many years earlier, most likely from when it was a sapling.

***Candalides absimilis* (Felder)**

Numerous eggs and several larvae in various instars were collected on the terminal stems and young soft shoots of Kurrajong *Brachychiton populneus* (Sterculiaceae), growing on the lower slopes of Dromedary Hill near Mt. Dromedary, Tilba Tilba, New South Wales, on 28 January 1996. The tree measured about 8–9 m high, and both males and females were observed flying in close proximity. Three females were netted as they were ovipositing on the plant, or feeding from the flowers of Sweet Bursaria *Bursaria spinosa* Cav. (Pittosporaceae), which grew nearby.

Four larvae from these eggs were successfully reared to the pupal stage in captivity on new growth of *B. populneus* (the remaining larvae apparently eating each other in captivity!). Three adults emerged later that year 7–10 months after pupation, with the following dates of emergence: 18 September 1996 (1male); 4 October 1996 (1male); 8 December 1996 (1female). Larvae of *C. absimilis* feed on many different plant species from several families, including the Flame Tree *Brachychiton acerifolium*. *B. populneus* has not previously been recorded as a larval food plant, although Dunn (1990) suspected that it may be used in eastern Victoria.

***Neolucia agricola* (Westwood)**

Fisher (1978) described and illustrated the early stages and provided brief notes on the life history. Larvae are known to pupate on the food plant and development is rapid, but the egg-laying habits and

complete life cycle have not been reported. The following observations were made during 1994-95 at Black Mountain, Australian Capital Territory, where *N. agricola* is univoltine.

Adults were locally abundant and on the wing from early November to mid December. Eggs were laid singly low down on the main stem of Narrow-leaf Bitter-pea *Daviesia mimosoides* R. Br. (Fabaceae), a small shrub about one to two metres high, and a hitherto unknown food plant. The eggs were well concealed, usually being deposited in the upper or lower angle between two branches or in the upper or lower angle between a branch and the main stem; sometimes, however, they were deposited on an old scar caused when a branch detached from the main stem. About 20 eggs were collected on 17 December 1994 and of these five were kept in captivity.

Inspection of the eggs 12 months later revealed that they had not hatched. *N. agricola* evidently survives the summer, autumn and winter period in the egg stage but the cues inducing, regulating and terminating the dormant period have not been established. The larvae are known to feed only on flowers of fabaceaous plants (e.g. Fisher 1978) and observations at Black Mountain indicated that *D. mimosoides* flowered for a very limited period, about four weeks from late September to late October. Hence egg hatching must coincide with flowering to synchronise larval feeding with the seasonal availability of flowers.

On 29 October 1995, five late instar larvae were collected from the food plant by beating the flowers. They pupated five days later and the adults emerged 16–20 days after pupation in mid November when most plants of *D. mimosoides* were in fruit. Egg dormancy has also been reported for *N. mathewi* (Common and Waterhouse 1981) and *N. hobartensis* (Quick 1973) and would seem characteristic of the genus.

Nacaduba biocellata (C.& R. Felder)

Several females were observed flying around and settling on the foliage and flower buds of a small tree of Lightwood *Acacia implexa* Benth. (Mimosaceae), at the summit of Gresswell Hill, La Trobe University, Victoria, on 20 January 1993. Two late instar larvae were subsequently recovered from the flower buds by beating the foliage. The larvae were reared on the buds of *A. implexa* but both were later found to be parasitised by a species of Diptera. *A. implexa* represents an additional food plant for *N. biocellata*.

Acknowledgements

I am grateful to Lyn Craven, CSIRO National Herbarium, for identifying the larval food plants of *Herimosa albovenata*, *Taractrocera papyria* and *Neolucia agricola*, and to Fabian Douglas, Ted Edwards and Cliff Meyer for assistance with field work. Ted Edwards and Cliff Meyer kindly read and improved a draft of the manuscript.

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Observations on the Ecology of *Muehlenbeckia costata* m.s. (Polygonaceae), a Rare Fire-ephemeral Species Occurring on the New England Batholith of Northern New South Wales and Southern Queensland

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Abstract
Muehlenbeckia costata m.s. (K.L.Wilson and Makinson sensu Wilson 1990) is a little known species found on recently burnt granitic outcrops on the New England Batholith. The species is a short-lived fire-ephemeral. An assessment of the potential population size of *M. costata* on the batholith after the 1994 fires was lower than 5000 individuals. In December 1996 the population was estimated to be under 200 individuals. The taxa and communities associated with this species are discussed and the ecology of *M. costata* is discussed in terms of current distribution, phylogeny, fire and conservation status. Management of this species is considered to be problematical. (*The Victorian Naturalist* **115**, 1998, 9–17).

Introduction

Muehlenbeckia costata m.s. (K.L.Wilson and Makinson) is a vulnerable, short-lived herb from high altitude rocky areas within New South Wales and the Darling Downs region of Queensland (Richards and Hunter 1997). This species has been collected from Mt Norman, a large granitic outcrop within Girraween National Park in Queensland, and other collections were made from recently burnt rocky outcrops at Mt Kaputar on the Northern Tablelands. There is also a single historical collection from Wallerawang on the Central Tablelands of New South Wales (K.L. Wilson *pers. comm.*). In 1973 John Williams collected a specimen of *M. costata* from a crevice in a large granitic outcrop within Bald Rock National Park in New South Wales. Binns (1992) reported the discovery of a few individual *M. costata* plants within Warra State Forest, south-east of Glen Innes, on recently burnt granitic outcrops in 1991. All of the recent collections were made on rocky outcrops from altitudes greater than 1100 m a.s.l.

The New England Batholith encompasses the major part of the north-east of New South Wales, as well as parts of south-eastern Queensland, extending for approximately 400 km in length and 110 km in width, from Stanthorpe in Queensland to Tamworth in New South Wales (Leigh 1968). In the last months of 1994 extensive fires occurred along the eastern portion of the New England Batholith and affected many areas of granitic outcrops at high altitude. Fortuitously, a survey of the granitic outcrop flora of the New England Batholith was being conducted (Hunter *in prep.*) at this time. Populations of *M. costata* were discovered in early 1995 in recently burnt crevices of granitic outcrops at Girraween and the adjacent Bald Rock National Park and within Warra State Forest (Hunter 1995). Further populations were discovered in Butterleaf State Forest, north-east of Glen Innes, in 1996 (Richards 1996; Richards and Hunter 1997).

Briggs and Leigh (1996) assigned a ROTAP code of 3KC- for *M. costata* which has subsequently been raised to 3VCa by Richards and Hunter (1997). Thus the change in conservation status means that the species has gone from a known distribution of more than 100 km (3), being poorly known (K) yet conserved (C), although adequacy of reservation is unknown (-), to being vulnerable (V),with adequate reservation status (a).

This paper presents significant knowledge gained about the population dynamics of *Muehlenbeckia costata*. Aspects of the fire response, population size, potential distribution and management strategies are also presented for this rare species.

Plant description

Muehlenbeckia costata m.s. (K.L. Wilson and Makinson) has separate male and female plants (dioecious), the stems lie along the ground (procumbent) and climb by twining. The stems may reach up to

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5 m in length and 4 m in height radiating from a central rootstock. The leaves are ovate, oblong to almost triangular, 3–14 cm long, 1–9 cm wide, with a more or less heart-shaped base (cordate) and wavy (crenulate) margins. Young leaves are often red, becoming green as they age, but retaining red on the margins, major veins, petioles and sometimes stems. The nuts are three-angled with a hard, black rugose coat. The perianth is initially green, but as the nut matures it becomes orange and fleshy, and elongates and swells to enclose the fruit and becomes the diaspore (dispersal unit). The plants appear to live for up to three years (Fig. 1).

Fig. 1. A seedling of *Muehlenbeckia costata* m.s. four months after germination, in flower.

Fig. 2. Summit of South Bald Rock within Girraween National Park, Queensland, a known site for *Muehlenbeckia costata* m.s.

Methods

Site characteristics

Bald Rock and Girraween National Parks are part of the largest area of granitic outcropping on the New England Batholith (Fig. 2), occurring north-east of Tenterfield in New South Wales and south-east of Stanthorpe in Queensland (Fig. 3). Approximately 17000 ha are included in these National Parks (McDonald *et al.* 1995) at an altitudinal range of 800–1277 m. The geology is largely Stanthorpe Adamellite with intrusions of Ruby Creek Granite.

Butterleaf State Forest lies 40 km north-east of Glen Innes (Fig. 3) and occupies 5156 ha of forest on terrain ranging from undulating to hilly over an altitudinal range of 900–1300 m. Directly to the north of the state forest a similar sized portion of land occurs in private ownership. Both the private land and the state forest have extensive patches of granitic outcrops, the most extensive being Mount Scott, within Butterleaf State Forest. The geology is Kingsgate Granite and medium to coarse-grained adamellite.

Warra State Forest, about 40 km south-east of Glen Innes (Fig. 3), includes a large area of leucoadamellite outcropping of the Oban River Granitoid Belt. This State Forest has a total area of 1891 ha which includes the 270 ha Crown Mountain Flora Reserve. The altitudinal range is from 990–1372 m.

Survey methods

The populations of *M. costata* at Crown Mountain Flora Reserve and Bald Rock and Girraween National Parks were visited in February 1995, approximately 4–5 months after the wildfire. The populations at Bald Rock and Girraween National Parks were visited once a month between December 1995–December 1996, and the populations at Crown Mountain Flora Reserve, Butterleaf State Forest and Bald Rock and Girraween National Parks were assessed in June 1996.

The extent of *M. costata* populations on the New England Batholith were assessed by direct observation via quadrats, and by traversing most of the granitic outcrops within the areas investigated. The locality and extent of fires on outcrops were noted while the assessments on populations were being made. The size of outcrops were measured with the aid of aerial photographs, topographic maps and ground truthing. The associated vegetation from the three known localities of *M. costata* on the New England Batholith was surveyed.

The data gathered for this article are based on the twenty-one 32×32 m (0.1 ha) quadrats where *M. costata* was found, and which form part of a more extensive survey of the New England Batholith granitic outcrop vegetation (Hunter, *in prep.*). Each

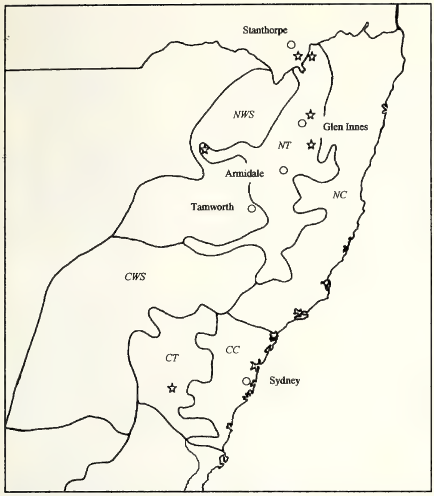

Fig. 3. Distribution of *Muehlenbeckia costata* m.s. across New South Wales.
Key: Botanical divisions - NC, North Coast; CC, Central Coast; NT, Northern Tablelands; CT, Central Tablelands; NWS, North Western Slopes; CWS, Central Western Slopes; (*) known localities.

quadrat had 10 subdivisions and represented a modification of the nested design discussed by Outhred (1984). Each quadrat was marked out by the placement of four 30 m measuring tapes marking the diagonals. Markings were placed on the measuring tapes at various distances from the centre of the quadrat 1, 1.4, 2, 2.8, 4, 5.7, 8, 11.2, 16 and 22.5 m. This divided the total quadrat into 10 sub-quadrats of approximate cumulative area; 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024 m^2. All vascular plant species present in each quadrat were recorded. The presence or absence of a taxon in each of the ten sub-quadrats gave a frequency score out of ten for each taxon, providing a measure of relative abundance.

Due to the large size of individual *M. costata* plants, it is assumed that actual numbers correlated closely with the frequency score out of ten gained from the nested quadrat method. For this reason the frequency score was used to estimate the potential extant population size of this species within the New England Batholith. However, the methodology for the more extensive survey of the Batholith required that more quadrats be placed on the larger outcrops and that their placement be random. It was assumed that the placement of quadrats provided a representation of

Table 1. Selected environmental parameters for currently known populations of *Muehlenbeckia costata* on the New England Batholith, climatic data based on BIOCLIM modeling.

Altitude	1150-1330 m
Annual Precipitation	876-1015 mm
Max Temp of the Warmest Period	22.6-24.1°C
Min Temp of the Coldest Period	0.0-1.1°C

the proportion of burnt and unburnt vegetation patches on the outcrops surveyed. Extant population estimates were extrapolated from the frequency score. For example, if on a 10 ha outcrop, 10 quadrats were placed covering an area of 1 ha, and five of these quadrats each had a frequency score of 4 for *M. costata*, then the estimate of the population size would be 200 for that outcrop. Estimates were then made of the potential total population size for an area by extrapolation of these results to other burnt outcrops with populations of *M. costata* found on traverses but not surveyed via the placement of nested quadrats.

Results

Population distribution and size

Populations of *M. costata* were only found on recently burnt rocky outcrops at altitudes above 1100 m (Table 1). Prior to these fires no individuals were found on the same outcrops (J.T.H. *pers. obs.*). Adjacent unburnt patches on the same outcrop had no germination of this species. Additionally, this species was only found on the largest of the rocky outcrops within any region, and generally these outcrops were over 10 ha in area. When *M. costata* was located on smaller outcrops, these were, in most instances, satellite outcrops within close proximity to the larger outcrops bearing populations of this *M. costata*. Burnt outcrops in other areas of the batholith yielded no further populations of this species. In no instance was a single germination seen for localities off the outcrops.

In early February 1995, only four to five months after the passage of wildfire, *M. costata* individuals had already spread 2 m in any direction from the central tap root and were flowering. Germination experiments on *M. costata* (Hunter *unpubl)* have shown flowering within 3–4 months after root appearance with specimens only

Area	Feb 1995 surveyed	Feb 1995 potential	Dec 1996 estimated
Bald Rock/ Girraween NP	765	1200	30
Butterleaf SF	140	300	10
Warra SF	1315	2000	60
Total number of plants	**2220**	**3500**	**100**

Table 2. Estimate of population size of *Muehlenbeckia costata* from the three areas surveyed (see methods for discussion of estimation technique). The first and second columns refer to estimates of extant population size in February 1995 on outcrops surveyed via quadrats (first column) and those extrapolated to include burnt outcrops not surveyed via quadrats (second column). The third column includes the estimate of the extant population size in December 1996.

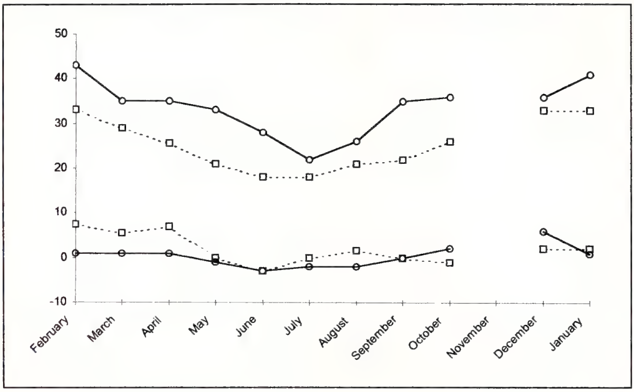

Fig. 4. Maximum and minimum temperature (°C) from a *Muehlenbeckia costata* granite outcrop site (solid line and circles) and an adjacent forest site (broken line and squares). The records are based on mid-month recordings taken at Bald Rock National Park from January 1996 to January 1997. The records for November are missing due to lack of access owing to local fires.

5 cm in length. Flowering and fruiting were noted on all occasions, including all monthly visits to populations within Bald Rock National Park, and it is assumed that flowering and fruiting are continuous from about three months after germination until senescence. Individuals of this species were found to extend up to 5 m from the central rootstock in any direction and clamber up the stems of nearby plants to a height of 4 m. A single plant was able to dominate an area 10 m in diameter and 4 m vertically when mature.

The estimated extant population size of *M. costata* on the batholith in February 1995 was less than 5000 individuals (Table 2), even though, visually, it appeared to be large. The largest population appears to have been in Warra State Forest, then Bald Rock and Girraween National Parks, with a minor population at Butterleaf State Forest (Table 2).

In June of 1996 most plants in all monitored localities had senesced, almost two years after original germination. Individuals that had not died were only perpetuating by small, *c.* 20 cm long, re-sprouting stems at the central taproot. At Warra State Forest, where the largest population occurred (Richards 1996), only four extant plants were found during an extensive search for this species in May 1996. Two extant individuals were still noted within Bald Rock and Girraween National Parks in December 1996. All plants were still flowering but a heavy infestation of a rust fungus was noted on all plants prior to, and during, the senescence of plants. *Muehlenbeckia. costata* endured extremes of temperatures in winter and neither frost nor temperatures over 40°C in summer adversely affected the plants (Table 1; Fig. 4). Drought was also a feature of 1995 but the populations did not appear to be stressed.

Site Floristics

A total of 169 taxa were found to be associated with *Muehlenbeckia costata* populations on the New England Batholith (Appendix 1). A number of rare or restricted taxa were present amongst them and included: *Acacia latisepala* (3RC-), *Callistemon flavovirens* (3RC-), *Callitris monticola* (3VC-), *Homoranthus papillatus* (2RC-t), *Leucopogon cicatricatus* (3RCa), *Mirbelia confertiflora* (3RCa); *Phebalium*

ambiens (3RC-), *Plectranthus suaveolens* (3RC-), *Prostanthera* sp. 'Boonoo Boonoo' (2RC-) (Briggs and Leigh 1996), *Brachyloma saxicola* (3RCa), *Eriostemon myoporoides* subsp. *epilosus* (3RCa), *Eucalyptus codonocarpa* (3RCa), *Kunzea bracteolata* (3RC-) (Richards and Hunter 1997) and *Monotaxis macrophylla* (Hunter and Bruhl 1997) which has been listed as an endangered species under the Threatened Species Conservation Act (New South Wales Government 1995).

All vegetation communities were heath and mallee. The dominant species of heaths varied, but most commonly included *Leptospermum novae-angliae* with other co-dominant species including *Kunzea obovata*, *Brachyloma saxicola*, *Acacia latisepala* and *Dodonaea viscosa*. The mallee communities differed primarily in the presence of *Eucalyptus codonocarpa* in the overstorey.

The ten taxa most closely associated with *M. costata* based on their summed frequency scores are, in decreasing order: *Entolasia stricta*, *Leptospermum novae-angliae*, *Platysace lanceolata*, *Lomandra longifolia*, *Kunzea obovata*, *Leucopogon neoanglicus*, *Gonocarpus oreophilus*, *Schoenus apogon*, *Monotaxis macrophylla*, and *Allocasuarina rigida*.

Discussion

All known occurrences of *M. costata* are on rocky outcrops at high altitudes, above 1100 m, and this appears to be a common feature of other *Muehlenbeckia* species (Brandbyge 1992). As a result, only a limited potential habitat is available on the New England Batholith. Granite outcrops on the batholith are extensive yet bare rock comprises around 90% of some outcrops (Fig. 2). Not all potentially available habitats are occupied by *M. costata*. Within Girraween and Bald Rock National Parks and Butterleaf and Warra State Forests not all burnt outcrops had populations of *M. costata*. In most instances only the largest outcrops had populations of *M. costata* and where smaller outcrops had populations of this species they were commonly satellite outcrops that surrounded the larger outcrops. This may explain why other areas with outcrops above 1100 m in altitude on the batholith, such as Guy Fawkes and Cathedral Rocks National Park, Bolivia Hill and Forest Lands State Forest did not have populations of *M. costata*. Only Warra and Butterleaf State Forests and Girraween and Bald Rock National Parks had very large rocky outcrops, of 12 ha or more. It is possible that the larger outcrops have populations of a critical size that are resistant to extinction.

A large number of seeds are produced over the life span of this species. A single plant may yield many hundreds of nuts at any one time, and production is continuous throughout the one to three year life of the plant. Much of the seed is viable; with one estimate being 63%, based on a tetrazolium test of 200 seeds (Hunter *unpubl. data*). Tetrazolium is a chemical that will stain the embryo within a seed red if it is alive and has the potential to germinate. If such a large seed rain is normal for this species, then the limiting factor must be in the local dispersal distance. Since if it was efficient, a larger number of burnt outcrops, including many of the smallest outcrops, should have had populations of this species and populations would be maintained as the species would be able to re-invade areas where it has become locally extinct. This, however, was not the case.

Brandbyge (1992) reports that *Muehlenbeckia* species with a succulent perianth are bird dispersed. The succulent diaspore of *M. costata* and its bright orange colour make this species a candidate for bird and probably lizard dispersal. Lizards form one of the most common faunal components of granitic outcrops on the New England Batholith. French and Westoby (1996) hypothesise that vertebrate seed dispersal is incompatible with habitats that have recurrent fires, seeds with fleshy coverings not being capable of surviving the high temperatures associated with fires. On the contrary *M. costata* has adaptations that not only allow the diaspore to be vertebrate dispersed (fleshy covering), but also allow it to withstand high temperatures associated with fires (thick, hard-walled nut). Germination (Hunter *unpubl. data*) of this species has occurred after heat treatment of 120°C for ten minutes. Therefore, it is not the fact that vertebrate dispersal is incompatible with fire prone habitats, but that the fleshy fruits, commonly associated with vertebrate dispersal, are incompatible with such habitats. The dispersal of a diaspore

needs to be divorced from the functional components of the diaspore.

Fire-ephemeral species have been noted in many communities and occur across a range of plant families (Gill 1993). The appearance of herbaceous fire-ephemeral species has been noted in other heath and mallee communities within Australia (Gill and Groves 1981; Gill 1993). *M. costata* appears to fall within the category of a fire-ephemeral species because:

I) germination is stimulated by the passage of fire,
II) individual plants have a short life span,
III) a large biomass is produced in a short period of time,
IV) flowering occurs shortly after germina tion, and
V) populations do not persist in the absence of fire. Life form traits such as those listed above are often considered a strategy devel oped as a consequence of evolving in a fire-prone environment.

It is expected that fire promoted taxa would occur in areas with a frequent occurrence of fire. However, granitic outcrops, especially large ones, are usually considered as refuge areas for taxa that are not fire adapted (Craven and Jones 1991). In general, fire occurs much less frequently on granitic outcrops than in the surrounding areas. Even in the 1994 fires which burnt 90% of Girraween National Park and a similar proportion of Warra State Forest, up to half of the outcrop communities were unaffected, including many small outcrops of about 1 ha in size (J.T.Hunter *pers. obs.*). Many of the communities on outcrops in the New England Batholith are of a substantial age, and humus development is considerable. Some larger outcrops (e.g. at Crown Mountain and South Bald Rock) are refugial areas for rainforest taxa such as *Quintinia sieberi*, *Rapanea* spp., *Notelaea* spp., *Tasmannia glaucophylla*, *Trochocarpa laurina*. Furthermore, the taxa on outcrops have a higher proportion of species killed by fire than in the surrounding communities (Hunter *unpubl. data*). This evidence indicates that fires are indeed much less frequent on outcrops, and may have fire intervals many times greater than the surrounding communities, and are thus unlikely to evolve a fire promoted flora. As such, only the most intense fires would be likely to affect substantial areas on the larger outcrops where *M. costata* is known to occur. It can, therefore, be thought of as paradoxical that a fire promoted species such as *M. costata* is not only restricted to granitic outcrops on the New England Batholith but is restricted to the largest outcrops.

Species are not independent entities and commonly share adaptations through a common ancestry. It is, therefore, important to examine the phylogenetic distribution of traits (Harvey and Pagel 1991). Brandbyge (1992) states that most species of *Muehlenbeckia* are 'weedy', rapidly build up a large biomass, and are characteristically found in open, rocky, sun-exposed habitats. The ecology of most species of *Muehlenbeckia*, apart from apparent fire promotion, share the life form traits listed here as fire-ephemeral characteristics. These traits are adaptations that, in general, allow *Muehlenbeckia* species to survive, and be promoted by, disturbance such as occurs on forest margins, in landslides, and along road verges (Henty 1978; Wilson 1990; Brandbyge 1992). It is, therefore, likely that *M. costata* is phylogenetically predisposed to growing on rocky outcrops and is promoted by disturbance. Granitic outcrop communities are potentially some of the least disturbed on the New England Batholith and fire, although relatively infrequent, is the only large disturbance with any regularity. Therefore, the promotive effect of fire on *M. costata* is probably more a consequence of it being a disturbance factor than to the species evolving a life form strategy due to a fire prone environment.

Conservation and management

The population size of *M. costata* is very small. Even under the most favorable conditions such as the fire events of 1994, the extant population of this species was estimated to be under 5000 individuals and was probably as low as 3000 individuals on the batholith (Table 2). In December 1996, the population size of this species was probably under 200 individuals and potentially under 100 (Table 2). The frequency of large and extensive fires such as those which occurred in 1994 is low and it is, therefore, not surprising that so few collections have been made of this species and so little is known of it. Human induced disturbance on granitic outcrops is, in general, low and

such habitats are considered well reserved. All areas on the batholith containing *M. costata* are reserved in some form. Bald Rock and Girraween are National Parks, Warra State Forest has the Crown Mountain Flora Reserve within it, and the area around Mt Scott in Butterleaf State Forest is designated as preserved native forest. The population size of *M. costata* will never be large and thus, it should be considered as a vulnerable species, despite the reservation status of most communities harbouring this species. The listing of *M. costata* as vulnerable given by Richards and Hunter (1997) should be retained under both the ROTAP and the RAVAS (Chalson and Keith 1995) scales based on the following criteria: the species is known from less than 10,000 individuals; less than ten populations are known; populations undergo extreme fluctuations over five years or more; habitat requirements are highly specific, and regeneration capacity is limited due to the above.

The development of management strategies for the promotion of this species is problematical. General fuel reduction burning in the surrounding forest and woodland systems are likely to decrease the likelihood of extreme fires which are needed to affect the larger outcrops. Furthermore, the communities on high altitude granitic outcrops of the New England Batholith have evolved with a frequency of fire that is less than that of the surrounding communities. Therefore, an increase in the frequency of fires on outcrops may have unforeseen effects on outcrop communities. Thus, management of this vulnerable species is problematical and will need separate consideration from general fire management plans for the region.

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Appendix 1

Plant species found associated with *Muehlenbeckia costata* on the New England Batholith and their frequency of occurrence, based on 21 nested-quadrats. Undescribed species follow descriptions of Harden (1990-1993).

Key: numbers represent presence in 21 quadrats; (*) indicates introduced species; (#) indicates restricted species.

PTERIDOPHYTES	
Aspleniaceae	
Asplenium flabellifolium Cav.	1
Davalliaceae	
Davallia pyxidata Cav.	1
Dennstaedtiaceae	
Pteridium esculentum (G.Forst.) Cockayne	5
Polypodiaceae	
Pyrrosia rupestris (R.Br.) Ching	8
Sinopteridaceae	
Cheilanthes sieberi Kunze subsp. *sieberi*	8
Pellaea falcata (R.Br.) Fèe	1
GYMNOSPERMS	
Cupressaceae	
Callitris endlicheri (Parl.) F.M.Bailey	1
Callitris monticola# J.Garden	2
Callitris rhomboidea R.Br. ex Ching	1
ANGIOSPERMS - MONOCOTS	
Anthericaceae	
Arthropodium milleflorum (DC.) J.F.Macbr.	4
Cyperaceae	
Bulbostylis densa (Wall.) Hand.-Mazz.	7
Fimbristylis dichotoma (L.) Vah.	3
Gahnia aspera (R.Br.) Spreng.	2
Gahnia sieberiana Kunth	9
Lepidosperma gunnii Boeck.	8
Lepidosperma laterale R.Br.	11
Schoenus apogon Roem. & Schult.	13
Schoenus melanostachys R.Br.	1
Scirpus polystachyus F.Muell.	5
Iridaceae	
Patersonia sericea R.Br.	12
Juncaceae	
Juncus bufonius L.A.S.Johnson	1
Juncus continuus L.A.S.Johnson	1
Lomandraceae	
Lomandra filiformis (Thunb.) Britten	2
Lomandra longifolia (R.Br.) Britten	17
Luzuriagaceae	
Eustrephus latifolius R.Br. ex Ker Gawl.	3
Orchidaceae	
Bulbophyllum elisae (F.Muell.) F.Muell. ex Benth.	1
Caladenia fuscata (Rchb.f.) M.A.Clem. & D.L.Jones	1
Cryptostylis subulata (Labill.) Rchb.f.	3
Dendrobium kingianum Bidwill ex Lindl.	2
Dendrobium pugioniforme A.Cunn.	1
Prasophyllum brevilabre (Lindl.) Hook.f.	3
Pterostylis decurva R.S.Rogers	1
Pterostylis longifolia R.Br.	1
Phormiaceae	
Dianella caerulea Sims	8
Dianella revoluta R.Br.	2
Dianella tasmanica Hook.f.	3
Stypandra glauca R.Br.	9
Thelionema caespitosum (R.Br.) R.J.F.Hend.	5
Poaceae	
Aristida jerichoensis (Domin) Domin ex Henrard	1
Danthonia linkii Kunth	3
Danthonia monticola Vickery	1
Danthonia pilosa R.Br.	1
Dichelachne rara (R.Br.) Vickery	1
Digitaria breviglumis (Domin) Henrard	5
Echinopogon caespitosus C.E.Hubb.	1
Entolasia stricta (R.Br.) Hughes	20
Eragrostis leptostachya (R.Br.) Steud.	2
Eragrostis tenuifolia (A.Rich.) Hochst. ex Steud.	3
Microlaena stipoides (Labill.) R.Br.	5
Paspalidium constrictum (Domin) C.E.Hubb.	7
Poa sieberiana Spreng.	4
Smilaceae	
Smilax australis R.Br.	1
ANGIOSPERMS - DICOTS	
Apiaceae	
Actinotus gibbonsii F.Muell.	10
Platysace lanceolata (Labill.) Druce	12
Trachymene incisa Rudge	10
Trachymene sp. aff. incisa	2
Araliaceae	
Astrotricha longifolia Benth.	1
Polyscias sambucifolius (Sieber ex DC.) Harms	4
Asteraceae	
Brachycome stuartii Hook.f.	5
Cassinia uncata A.Cunn. ex DC.	1
Chrysocephalum apiculatum (Labill.) Steetz	1
*Conyza albida** Spreng.	4
*Conyza bonariensis** (L.) Cronquist	4
*Gnaphalium americanum** Mill.	2
Gnaphalium sphaericum Willd.	3
*Hypochaeris radicata** L.	18
Olearia oppositifolia (F.Muell.) Lander	2
Ozothamnus diosmifolius (Vent.) DC.	3
Senecio sp. E	2
Solenogyne bellioides Cass.	1
*Sonchus oleraceus** L.	1
Campanulaceae	
Wahlenbergia gracilis (G.Forst.) A.DC.	1
Casuarinaceae	
Allocasuarina littoralis (Salisb.) L.A.S.Johnson	4
Allocasuarina rigida (Miq.) L.A.S.Johnson	8
Chenopodiaceae	
Chenopodium pumilio R.Br.	2
Chloanthaceae	
Chloanthes parviflora Walp .	2
Crassulaceae	
Crassula sieberiana (Schult. & Schult.f.) Druce	1

Dilleniaceae	
Hibbertia acicularis DC.	2
Hibbertia sp. aff. *monogyna#*	5
Hibbertia serpyllifolia R.Br. ex DC.	5
Elaeocarpaceae	
Elaeocarpus holopetalus F.Muell.	1
Elaeocarpus reticulatus Sm.	1
Epacridaceae	
Acrotriche aggregata R.Br.	2
Brachyloma daphnoides subsp. *glabrum* (Blakely) J.T.Hunter	1
Brachyloma saxicola# J.T.Hunter	1
Epacris microphylla R.Br.	1
Leucopogon cicatricatus# J.M.Powell	1
Leucopogon lanceolatus (Sm.) R.Br.	9
Leucopogon melaleucoides A.Cunn. ex DC.	5
Leucopogon microphyllus (Cav.) R.Br.	3
Leucopogon neoanglicus F.Muell. ex Benth.	12
Monotoca scoparia (Sm.) R.Br.	8
Styphelia viridis Andrews	2
Euphorbiaceae	
Monotaxis macrophylla# Benth.	9
Phyllanthus virgatus G.Forst.	1
Poranthera microphylla Brongn.	3
Fabaceae	
Aotus subglauca Blakely & McKie	1
Bossiaea neo-anglica F.Muell.	6
Bossiaea rhombifolia Sieber ex DC.	1
Bossiaea scortechinii F.Muell.	2
Dillwynia phylicoides A.Cunn.	10
Hovea sp. A.	12
Mirbelia confertiflora# Pedley	7
Goodeniaceae	
Dampiera stricta (Sm.) R.Br.	7
Goodenia bellidifolia Sm.	3
Goodenia hederacea Sm.	4
Velleia paradoxa R.Br.	8
Haloragaceae	
Gonocarpus micranthus Thunb.	8
Gonocarpus oreophilus Orchard	7
Gonocarpus teucrioides DC.	8
Lamiaceae	
Ajuga australis R.Br.	1
Plectranthus suaveolens# S.T.Blake	1
Prostanthera saxicola R.Br.	1
Prostanthera scutellarioides (R.Br.) Briq.	1
Prostanthera sp Boonoo Boonoo#	4
*Prunella vulgaris** L	1
Lobeliaceae	
Isotoma anethifolia Lindl.	1
Mimosaceae	
Acacia falciformis DC.	8
Acacia latisepela# Pedley	5
Acacia ulicifolia (Salisb.) Court	10
Acacia venulosa Benth.	8
Acacia viscidula Benth.	2
Myrtaceae	
Callistemon flavovirens# (Cheel.) Cheel.	1
Callistemon pallidus (Bonpl.) DC.	6
Calytrix tetragona Labill.	4
Eucalyptus acaciiformis H.Deane & Maiden	7
Eucalyptus andrewsii Maiden	4
Eucalyptus banksii Maiden	1
Eucalyptus caliginosa Blakely & McKie	4
Eucalyptus campanulata R.T.Baker & H.G.Sm.	1
Eucalyptus codonocarpa# Blakely & McKie	8
Kunzea bracteolata# Maiden & Betche	2
Kunzea obovata Byrnes	12
Leptospermum brevipes F.Muell.	5
Leptospermum novae-angliae Joy Thomps.	19
Leptospermum polygalifolium subsp. *transmontanum* Joy Thomps.	5
Oleaceae	
Notelaea sp. A	2
Phytolaccaceae	
*Phytolacca octandra** L.	1
Pittosporaceae	
Billardiera scandens Sm.	2
Polygalaceae	
Comesperma ericinum DC.	1
Portulacaceae	
Calandrinia pickeringii A.Gray	3
Portulaca bicolor F.Muell.	1
Proteaceae	
Banksia spinulosa Sm.	7
Hakea dactyloides (Gaertn.) Cav.	7
Lomatia fraseri R.Br.	5
Lomatia silaifolia (Sm.) R.Br.	2
Persoonia cornifolia A.Cunn. ex R.Br.	2
Persoonia oleoides L.A.S.Johnson & P.H.Weston	1
Rubiaceae	
Opercularia aspera Gaertn.	1
Opercularia hispida Spreng.	1
Pomax umbellata (Gaertn.) Sol. ex A.Rich.	5
Rutaceae	
Boronia anemonifolia A.Cunn.	6
Boronia anethifolia A.Cunn. ex Endl.	1
Eriostemon myoporoides subsp. *epilosus#* Paul G.Wilson	5
Phebalium ambiens# (F.Muell.) Maiden & Betche	5
Phebalium ozothamnoides Benth.	1
Phebalium squamulosum Vent. subsp. *squamulosum*	1
Zieria fraseri Hook.	3
Zieria laevigata Bonpl.	5
Santalaceae	
Exocarpos cupressiformis Labill.	5
Sapindaceae	
Dodonaea viscosa Jacq.	7
Solanaceae	
Solanum cinereum R.Br.	2
Solanum opacum A.Braun & Bouche	2
Stackhousiaceae	
Stackhousia monogyna Labill.	1
Stackhousia viminea Sm.	4
Stylidiaceae	
Stylidium graminifolium Sw. ex Willd.	1
Stylidium laricifolium A.Rich.	5
Thymelaeaceae	
Pimelea linifolia Sm.	9
Verbenaceae	
*Verbena bonariensis** L.	1

Reptiles and Birds in the Diets of the Eastern Barred Bandicoot *Perameles gunnii* and the Northern Brown Bandicoot *Isoodon macrourus*

R. J. de B. Norman[1]

Abstract

This paper records data on some components of alimentary tract contents from Eastern Barred Bandicoots *Perameles gunnii* and Northern Brown Bandicoots *Isoodon macrourus*. The first record of reptiles in the diet of *P. gunnii* is reported. (*The Victorian Naturalist* **115**, 1998, 18-20).

Introduction

A small number of studies of the diets of bandicoots have been published. McKeown (1951) noted several components of the faeces of the Long-nosed Bandicoot *Perameles nasuta* in New South Wales. Heinsohn (1966) gave a detailed account of the diets of the Southern Brown Bandicoot *Isoodon obesulus* and the Eastern Barred Bandicoot *Perameles gunnii* in Tasmania, based on stomach contents of animals killed for the study. Comments on food species available in his study areas, and descriptions of feeding behaviour were included. Heinsohn (1966) generalised that introduced lumbricid earthworms were the main food of *P. gunnii* during the wet months, while insects were the main food during the dry season. A similar pattern was observed in the diet of *I. obesulus*. Earthworms, adult beetles, and phalaenid moth and other lepidopteran larvae made up the bulk of the diets of both bandicoot species. The only plants identified as important were seasonally available berries. Quin (1985) examined faeces of *I. obesulus* in Tasmania, and quantified the available and selected invertebrate prey species. The diet of *I. obesulus* appeared to reflect seasonally and locally abundant food items. Ants, adult and larval beetles, spiders, grasses, seeds, clover root nodules and fungi were regarded as important foods. Some information on the diet of *P. gunnii* in Victoria can be found in Seebeck (1979), Brown (1989) and Dufty (1991) based mainly on observations of feeding. *Perameles gunnii* is mainly insectivorous, but also consumes a variety of plant and other invertebrate species. Dufty (1994) quantified dietary components in stomachs of road killed *P. gunnii*, and in faeces, and found mainly Oligochaeta, supplemented with Coleoptera and Orthoptera, and occasionally Lepidoptera and Hymenoptera. Monocotyledonous plant material was also common. Wright and others (1991) examined the dentition and alimentary tract contents of a museum specimen of the Pig-footed Bandicoot *Chaeropus ecaudatus* and concluded this extinct species was a specialist grazing herbivore. Vertebrates are seldom reported in the diets of bandicoots. Heinsohn (1966), in his Tasmanian study, recorded a frog in the stomach of a *P. gunnii*, a skink *Lygosoma* sp. in the stomach of an *I. obesulus*, and a hylid frog in the mouth of a road killed *I. obesulus*. Cogger (1994) stated skinks in the genus *Lygosoma* are not represented in Australia. Nagy *et al.* (1991) list frogs in the genus *Helioporus* (sic) as a normal diet component of *I. obesulus*. Burrowing frogs in the genus *Heleioporus* are present in south-western Australia and the coast and ranges of south-eastern Australia, but not Tasmania (Cogger 1994). Captive Tasmanian *P. gunnii* and *I. obesulus* readily consumed dead baby mice (Heinsohn 1966).

The purpose of this note is to record some components of alimentary tract contents from *P. gunnii* and Northern Brown Bandicoots *Isoodon macrourus*, including reptile and bird remains, observed incidentally during a study of parasitic disease (Norman and Chilton 1994).

Methods

Cadavers and alimentary tracts of 58 *P. gunnii* from Victoria which died

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between 1980 and 1991 were examined. Faeces from wild and captive *P. gunnii* from Victoria were examined during 1990 and 1991. Cadavers of 39 *I. macrourus* killed by road traffic during two weeks in October-November 1991 on the Atherton Tablelands, Queensland were examined.

Cadavers were examined fresh when available, or were frozen and then defrosted, or had been preserved entire in 70% alcohol or 10% formalin. Some abdominal viscera had been dissected and frozen or preserved in 70% alcohol before they were examined. Gastrointestinal tracts and their contents were examined using a binocular dissecting microscope. The material examined from *P. gunnii* is held in the Victorian Fisheries and Wildlife Division (FWD) collection at the Museum of Victoria. Logistic constraints during fieldwork in Queensland prevented the retention of alimentary tract contents from *I. macrourus*.

Results

Perameles gunnii

The sample of 58 *P. gunnii* consisted of 37 males, 17 females and four whose sex could not be determined. Twenty-one animals were killed by road traffic, 18 were killed by cats, dogs or foxes and 19 died of miscellaneous or unknown causes.

Stomachs normally contained both plant and invertebrate remains. Invertebrates were represented by both chitinous structures and soft-bodied animals. Soil was normally readily identifiable in stomach contents. Lengths of dry or green grass up to 10 cm long were found occasionally. Fur was sometimes found, presumably ingested during self-grooming.

Four small skinks were found amongst the stomach contents of a mature male killed by road traffic in Hamilton. These partially macerated specimens were tentatively identified as *Bassiana duperreyi*, the Eastern Three-lined Skink. (FWD No. 14911).

Several small feathers were found amongst the ingesta of another mature male killed by road traffic in Hamilton. (FWD No. 14512).

The youngest animals examined in this series were three sibling females weighing 101 g, 112 g and 120 g (headlengths respectively 52 mm, 55 mm, and 53 mm), which had been killed by a cat. The stomachs of these animals were moderately well filled with ingesta which included plant and invertebrate material. (FWD Nos. 13317-13319).

Faeces collected in the field were dark brown to black and were a conglomerate of invertebrate exoskeleton fragments, soil and plant material. Faeces of captive animals fed an artificial diet consisting of proprietary pet foods, eggs, mealworms, chopped fresh fruits and vegetables and forage herbage with *ad libitum* water, tended to be bulky, light brown or tan and homogeneous in consistency. When a supplement of live invertebrates was offered in a soil or sand substrate the faeces of captive bandicoots more closely resembled those of bandicoots foraging in the wild, particularly gaining a conspicuous soil component.

Isoodon macrourus

The sex of 13 of the 39 *I. macrourus* killed on the road could not be determined because of trauma, while four were female and 22 were male.

Many animals' stomachs contained pale, macerated, fibrous vegetable material whose origin could not be determined. Invertebrate remains were encountered frequently. The proportion of soil in ingesta was not noted, though soil was often present. Fur was found in the stomach of an animal with patchy alopecia.

The stomachs of two males each contained a lizard. The remains of a bird were found in the intestine of a third animal, whose sex could not be determined.

Discussion

Diets of bandicoots have been determined from observation of feeding behaviour, alimentary tract contents of dead animals, faeces and by inference from dentition. In the present study stomach and intestine contents from 97 bandicoots were examined in the course of work on parasitism and disease, though dietary study was limited to identification of vertebrate remains, and more general observations on soil, plant and invertebrate components. Quantitative methods were not used in examining diet in these animals as this was outside the scope of the primary parasitological and pathological study. Despite these limitations, interesting new

information on the diet of two species of bandicoots has been revealed.

Reptiles have not previously been recorded in the diet of *P. gunnii*. The feathers found in the stomach of another *P. gunnii* suggest that a bird was eaten, but whether as prey or carrion is not known. Fur presumably was ingested during self grooming, with the *I. macrourus* suffering from obvious patchy alopecia. Hair shafts were not subjected to specialist identification.

Heinsohn (1966) recorded independent feeding by *P. gunnii* in captivity from an age of 59 to 60 days, and he also reported a 55 day old juvenile *P. gunnii* foraging with its mother. Those juveniles included in the present study would be between 55–60 days old (Heinsohn 1966), therefore confirming that wild juveniles are foraging at this age.

McKeown (1951) noted soil in faeces from *P. nasuta*. The function or importance of soil in bandicoot nutrition has not been studied, although its origin is presumably due to the well-documented feeding behaviour involving the exploration of the soil through conical pits dug with the forepaws and snout (Heinsohn 1966). Ingestion of soil adherent to invertebrate, plant, or fungus food items obtained in this way may be unintentional, but may still be functionally important. Insects are recognized to be an inadequate source of dietary calcium (Wise 1990). Soil, whether ingested inadvertently or deliberately, may provide a supplement to minerals deficient in the selected diet species. By way of comparison, the Nine-banded Armadillo *Dasypus novemcinctus* primarily consumes insects, but also ingests a significant amount of dirt which makes up 5–10% by weight of the diet (Walsh *et al.* 1978). The significance of soil ingestion by wildlife as a route of exposure to environmental pollutants has been reviewed (Beyer *et al.* 1994).

The presence of vertebrate remains in the alimentary tracts of two of 58 *P. gunnii* and three of 39 *I. macrourus* examined in the present study confirms that vertebrates are of relatively minor importance in the diets of these bandicoots. However, this new record of reptiles and birds in their diets suggests a broader and possibly more opportunistic feeding strategy than previously recognized.

Acknowledgements

Peter Robertson, NRE, Flora and Fauna Branch is thanked for identifying the skinks from the *P. gunnii* killed at Hamilton. Thanks are extended to John Seebeck and Cor Lenghaus who provided much of the Victorian material referred to here, and also to Kath Handasyde, Liz Norman, and colleagues at the Royal Melbourne Zoo. Bandicoots killed by road traffic in Queensland were collected under permit no. T00576. The author was supported by a Fellowship grant from the Zoological Board of Victoria and the Chicago Zoological Society.

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The Old Orbost Road

R.J.Fletcher[1]

Abstract
The Natural History and the Social History of the Old Orbost Road in East Gippsland are inextricably intertwined. This paper endeavours to explore some aspects of both, and to offer some insight into the interconnections. (*The Victorian Naturalist* 115, 1998,).

We take for granted that a journey to East Gippsland will be taken along the Princes Highway. There will be no obstacles except the occasional traffic-light as we are obliged to slow down a little passing through one of the towns not yet by-passed. There will be no problems encountered as we cross a river or a swamp. There will be a bridge.

For untold thousands of years the Kurnai people travelled through the area on foot. Their trade routes, and seasonal tracks between hunting and gathering areas, would, over that time, have become well defined. There is little doubt that the first Europeans who travelled in the area – explorers, gold seekers, and grass hunting pastoralists – made use of the existing tracks of the hunter-gatherers. The first known Europeans in the area were shipwrecked sailors, in 1797, who were cared for by the local tribe.

The first serious attempt at settlement along the coast east of the Gippsland Lakes was at Orbost in 1848, when land along the Snowy River was taken up. Traffic in and out of the area was for many years by boat, a shipping company being set up for the purpose. The only viable alternative routes were along the beach from 'Cunninghame' now Lakes Entrance, to Marlo, or along a bridle path from the same place to Orbost. This bridle path may well have been one of the Kurnai tracks. It was widened to take a wagon during 1885, and in 1886 the first mail-run by coach from Lakes Entrance to Orbost began. This mail-run was to continue until 1916, the year the rail service was extended from Bairnsdale to Orbost. The first part of the Old Orbost Road was across 'The Bar', that is the sandbar separating Lake Tyers from Bass Strait. 'Crossing the bar' was frequently fraught with difficulty, and at times, the rare occasions when the lake was open to the sea, impossible (Fig.1). In the early days the crossing of the lake was made by row-boat if the bar were open, but during the nineties a small steamboat, the 'Firefly', was brought over from Tasmania, and towed barges around and across Lake Tyers until 1914, when the railway reached Nowa Nowa and new roads ended an era (Fig. 2).

Having crossed the bar, the coach still had a difficult progress across a swampy area, really the beginning of Ewings Marsh, before it reached the comparatively easy track through the bush. This swampy

Fig. 1. The Old Orbost Road crosses the morass near the bar at Lake Tyers.

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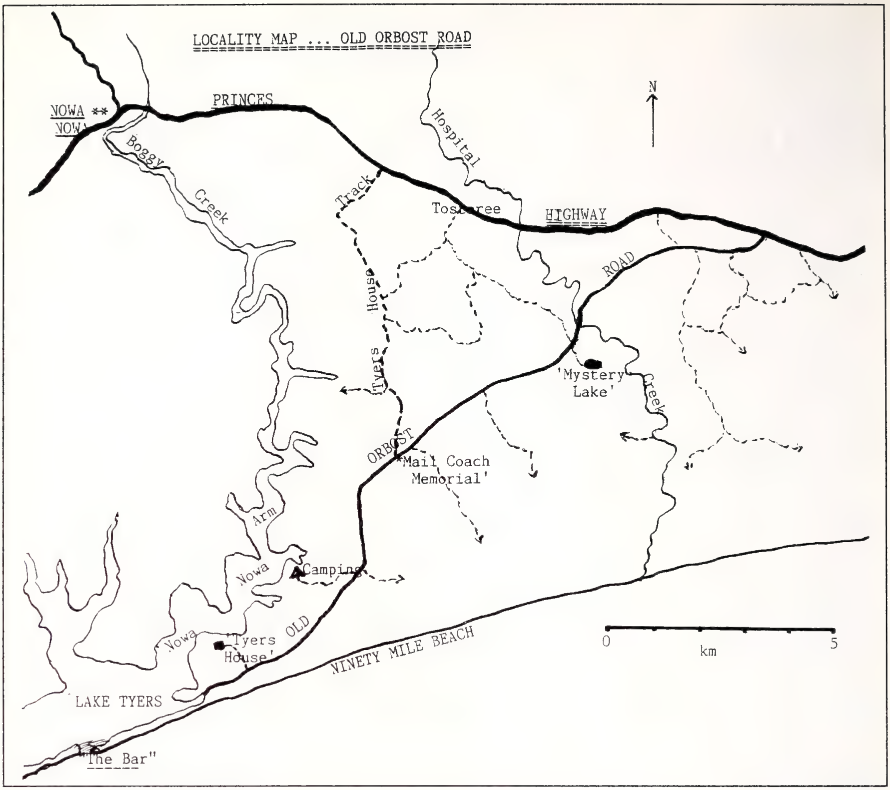

Fig. 2. The Old Orbost Road

section of the Old Orbost Road is still there, but closed off at the eastern end by a locked gate. This area was often under water and rotting vegetation gave it the unenviable name of 'The Stinkpot'. In this swamp or morass area are to be found a variety of rushes, including those listed in Table 1. Other plants typical of this kind of habitat include those in Table 2. Around the periphery of the swamp may be seen the species noted in Table 3 (Fig.3).

Before leaving the morass, a side trip to the shore of Lake Tyers reveals a bit of history. A very large brick chimney and a slab of concrete mark the site of a glass-works established in 1908 by Edward Roberts, who had also brought the steamer onto the lake. Nearby, rusting on the shore, is a ship's boiler, probably all that remains of the 'Firefly'. The glassworks survived until 1914, the main product being insulators for the new-fangled telegraph.

As the morass is left behind you enter what a traveller, Nathan Spielvogel, described in 1907 as a great virgin forest, a dense, thick expanse of tall Stringybark interspersed with Bluegums, Wattles and Ironbarks. He also reported that the track wound along a narrow path between tall trees and every trunk bore the the marks where it had been hit by passing vehicles. Fortunately the track has improved and the tree trunks are no longer such a hazard! The forest can no longer be classified as virgin, but it is surprisingly unspoiled. Areas along the old road have been used for grazing, especially in the Tostaree and Hospital Creek localities, and there has been timber taken out, the timber-getters no doubt being responsible for the number of side-tracks. The cutting of railway sleepers was a major activity early this century when the railway was being built, and many tall trees were taken to build the

Table 1. Species to be found in 'The Stinkpot':

Rush, Bristle	*Chorizandra australis*
Rush, Sea	*Juncus krausii*
Rush, Twig	*Baumea sp.*
*Sedge, Umbrella	**Cyperus eragrostis*

Table 2. Species to found around the periphery of 'The Stinkpot':

Appleberry, Common	*Billardiera scandens*
Ballart, Cherry	*Exocarpus cupressiformis*
Fan-flower, Creeping	*Scaevola hookeri*
Lignum, Climbing	*Muehlenbeckia adpressa*
Monkey Flower	*Mimulus repens*
Noon-flower, Rounded	*Disphyma crassifolium*
Spurge, Broom	*Amperea xiphoclada*

Table 3. Species to be found around the periphery of the swamp:

Banksia,Coast	*Banksia integrifolia*
Beard-heath, Coast	*Leucopogon parviflorus*
* Dolichos, Common	**Dipogon lignosus*
Gum, Manna	*Eucalyptus viminalis*
Paperbark, Swamp	*Melaleuca ericifolia*
Tea-tree, Coast	*Leptospermum laevigatum*
Wattle, Coast	*Acacia sophorae*

Table 4. Some of the species of Eucalypt in the Tildesley Forest Block:

Box, Red	*E.polyanthemos*
Gum, Swamp	*E. ovata*
Ironbark, Red	*E.tricarpa*
Mahogany, Southern	*E. botryoides*
Messmate	*E. obliqua*
Peppermint, Narrow-leaved	*E. croajingolensis*
Silvertop	*E. sieberi*
Stringybark, White	*E. globoidea*
Stringybark, Yellow	*E. muelleriana*

Table 5. Some of the variety of understorey species in a small area:

Arrow-grass, Streaked	*Triglochin striatum*
Blue-lily, Nodding	*Stypandra glauca*
Fern, Common Maidenhair	*Adiantum aethiopicum*
Fern, Gristle	*Blechnum cartaligineum*
Fern , Scrambling Coral	*Gleichenia microphylla*
Flax-lily, Black-anther	*Dianella revoluta*
Flax-lily, Tasman	*D. tasmanica*
Grass, Kangaroo	*Themeda triandra*
Grass-tree, Small	*Xanthorrhoea minor*
Orchid, Hyacinth	*Dipodium roseum*
Saw-sedge, Red-fruited	*Gahnia sieberiana*
Saw-sedge, Thatch	*G. radula*
She-oak, Drooping	*Allocasuarina verticillata*

Fig. 3. *Banksia integrifolia* along the Old Orbost Road.

Fig. 4. A typical scene along the Old Orbost Road in the Tildesley Forest.

amazing trestle bridges, one of which may be seen near Nowa Nowa on Stony Creek and another alongside the Princes Highway at Hospital Creek.

Because of the undulating nature of the area, generally known as the Tildesley Forest Block and hopefully earmarked for preservation as the Lake Tyers State Park, conditions are very variable, giving rise to a wide range of habitats. This is strikingly illustrated by the many species of eucalypts to be seen, for example those listed in Table 4 and the assurance of the Forester-in-Charge that this is only a part of the picture. The understorey is equally variable, changing constantly as you move from the higher, drier areas to the depressions and creek beds (Fig.4). For instance, one may see in a small area the species listed in Table 5.

In the Tostaree area, settled in the 1890's by the Jonson family and whose descendants still live there, there is a *Pinus radiata* plantation. This was planted in the 1960's as an experiment which would appear to have been unsuccessful. In more recent times, extensive areas formerly used for grazing have been planted with a variety of eucalypts. These are selection trials for plantation purposes, and include *Eucalyptus botryoides, E. globulus, E. nitens, E. obliqua* and some others. Near to this area are old stockyards and growing alongside a massive old Silvertop *E. sieberi* which looks venerable enough to have been growing there since the road was a track. A little further on there are two properties still being grazed, and of particular interest is their location around Lake Mystery (Fig.5). This extensive sheet of water has been the subject of tall tales and true from both the Kurnai people and the more recent Europeans. There is probably no mystery at all, but the area is unusual enough to have excited people's imaginations for millenia.

Soon after passing this area, there is a low level crossing over Hospital Creek. This is rather more a ford than a bridge, and would be marginally better than the corduroy log crossing it replaced. In the old days this was one of the more difficult spots on the road, the bank on the eastern side at that time being quite steep. The dense bush here could be characterised as East Gippsland Rain Forest, with a very wide range of plants, such as are listed in Table 6.

The timber and undergrowth change as the road rises from the Hospital Creek valley, and here may be found a variety of *Acacia* species, including Golden Wattle *Acacia pycnantha* and probably at least half a dozen other species.

Fig. 5. Lake Mystery near Tostaree on the Old Orbost Road.

Table 6. Some Gippsland Rainforest species near Hospital Creek.

Berry, Wombat	*Eustrephus latifolius*
Burgan	*Kunzea ericoides*
Clematis, Forest	*Clematis glycinoides*
Geebung, Narrow-leafed	*Persoonia linearis*
Glycine, Twining	*Glycine clandestina*
Hop-bush, Large-leaf	*Dodonea triquetra*
Indigo, Austral	*Indigofera australis*
Lilly-Pilly	*Acmena smithii*
Mahogany, Southern	*Eucalyptus botryoides*
Mistletoe, Drooping	*Amyema pendula*
Pittosporum, Sweet	*Pittosporum undulatum*
Pomaderris, Hazel	*Pomaderris aspera*
Tylophera, Bearded	*Tylophera barbata*
Wattle, Sunshine	*Acacia terminalis*

Soon after this, the Old Orbost Road makes a junction with the Irish Waterholes Road, and it is not immediately clear where the original might have gone. Older maps show a track directly east from here, but there is no sign of that. However, a little to the south there is a track called Old Orbost Extension and another leading back out to the Princes Highway called Old Orbost Link. It may well be that the Old Orbost Road included a small section of the Irish Waterholes Road and met up with what was then the Orbost Track at Partellis Crossing. There was once a hotel here when the railway was being built. Whatever the situation, the Old Orbost Road made a junction here with the Orbost Track, which was a branch from the Bruthen-Buchan Road through Nowa Nowa, a mile or so from the Hartland River. The bridge over this river, which is in fact signposted as Wombat Creek, is a short distance down-stream from where there was originally a ford and later a low level bridge. Since the re-alignmnent of the Highway these sites are on private property.

The journey from Cunninghame to Orbost along the Old Orbost Road and the Orbost Track could have taken anything up to ten hours by coach depending on conditions. It is quite a different story now, and if anybody interested in natural history is travelling to East Gippsland, it is recommended that a diversion be made down the Tyers House Track, about 6 km east from Nowa Nowa. This intersects with the Old

Fig. 6. Memorial to the coach drivers of the Old Orbost Road erected by the Jonson family of Tostaree in 1993.

Orbost Road about 9 km in from the Highway and is clearly signposted. There is also a plaque erected by the Jonson family as a memorial to the coach drivers who made the journey along rough bush tracks (Fig. 6). Today there is a good formed track suitable for the family car, and the trip could be done in an hour. But beware, it took the author a day and a half, and next time might take even longer!

Acknowledgements

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From our Naturalist in Residence, Ian Endersby

The Autumn Peeper

About the 22nd of February each year I listen for the first evanescent peeping calls that tell me that Autumn has arrived. If you live in the outer metropolitan areas of Melbourne you might have heard the high pitched *peep-peep-peep-peep* that commences after dark and seems to come from somewhere in the trees. It has a ventriloqual quality and almost always stops as you approach or shine a torch about. After much searching Graeme Pizzey finally located and photographed one and published its photo in his weekly newspaper article in 1977. The call was found to come from a small ground-dwelling cricket, less than 2 cm long, and in the genus *Eurygryllodes* (formerly *Eugryllodes*) Like all crickets it calls by scraping one heavily veined forewing across the other.

Once you know what it looks like and realise that it lives on the ground and will stop calling when you approach, they can be found. For nearly twenty years I have noted when they first called and tried to work out what triggers them to start. It is usually the night of the first rains after the middle of February, but not always. Keeping captive specimens has revealed some interesting aspects of their lives and may have provide an answer to what starts them off each year.

Eurygryllodes calls by raising its chitinous forewings and scraping one across the other. The membranous hindwings seem to be attached to the forewings by their outer edges so when the sound producing forewings stridulate the hindwings hang down forming a little sounding box which directs, and possibly magnifies the sound. So, where are these males directing their calls?; for it is only the male which calls. Either they are defending a territory or trying to attract and impress a mate. I have not yet seen a female and so I left caged, calling males outside to see if females would cluster around. They didn't, nor were pitfall traps successful. The next experiment was to put two males together in a container to see how they reacted. Whenever one started to call the other would respond until they were standing back to back and peeping alternately. There is no doubt that the sound is territorial. I don't know whether there is a different call for mate attraction but David Rentz (CSIRO's Orthopteran specialist) tells me that most stridulating grasshoppers and crickets have different calls for the two purposes. I wonder if *Eurygryllodes* has both types and, if so, what the second one is like; I can detect no difference in the field and, in captivity, a smaller specimen seems to have a slightly higher pitched call than a larger one but there is no obvious difference.

The rate of calling for some grasshoppers depends on the ambient temperature and so *Eurygryllodes* had to have that measured too. The number of peeps per minute was measured for one captive male on different nights when the inside temperature was different. There was quite a lot of variation within each sample but plotting the mean plus or minus one standard deviation gave a band that definitely decreased with temperature. Extrapolating the curve suggests that below about 10 or 11°C the rate of calling approaches zero peeps per minute.

The story of *Eurygryllodes* seems to be that males emerge from diapause or quiescence about the middle of February and their territorial calling is triggered by the next Autumn rain. However, they won't call if the weather is too cold and will wait for a warmer night. Unfortunately, I don't have overnight temperatures for the last twenty Februaries; when I do unearth them I might be able to confirm my theory.

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Defoliation of Silver Wattles *Acacia dealbata* at Glynns Reserve, Warrandyte

The Field Naturalists Club of Victoria is conducting a survey of the invertebrate fauna of Glynns Reserve, Warrandyte. This reserve, part of the Yarra Valley Parks and managed by Parks Victoria, has an extensive frontage to the Yarra River.

On 20 September 1997 members of the FNCV survey team noted that Silver Wattles *Acacia dealbata* growing along the river and on the river terraces had been totally defoliated and, in fact, appeared dead. During earlier work in July, all these wattles were in full leaf and blossom.

Glen Jameson, Conservation Ranger with the Yarra Valley Parks, indicated that beetle larvae had caused the defoliation, and that the Museum of Victoria staff had tentatively identified a specimen of the larva as belonging to the genus *Paropsis*. Identification from larvae is difficult and adult beetles are needed for a positive identification.

Subsequent discussion with a 'beetle expert' - Peter Kelly, long-time FNCV member - revealed that the most likely species involved in the defoliation was *Pyrgoides orphana*, a green and cream-striped beetle in the family Chrysomelidae.

Samples of two different species of adult beetles and the olive-green larvae were collected (27 September). On the same day several hundred larvae were observed massing on three wattle trunks. There was no apparent direction to their movements since as many were going up as down.

Defoliated Silver Wattles *Acacia dealbata on* the river terraces at Glynns Reserve

Later, Peter Kelly positively identified the specimens. One of the adult beetle species was identified as *Pyrgoides orphana*, a green and cream striped leaf beetle, 4 mm long, sub-family Chrysomelinae, family Chrysomelidae (see Cover drawing).

The olive green larvae, about 10 mm long, were also identified as *P. orphana,* and these were responsible for the defoliation.

The second adult beetle species, a small, 2 mm long, bronze-coloured beetle,was identified as belonging to the family Chrysomelidae, sub-family Gryptocephalinae. This species was not involved in the massive defoliation of the wattles.

The role of *P. orphana* in the defoliation of *A. dealbata* and *A. mearnsii* has been well documented (McKeown 1942; Crawford and Van Baer 1970; Lawrence and Britton 1994). This beetle has been called the Fire Blight Beetle, since the defoliated wattles are similar in appearance to plants affected by Fire Blight disease.

Further discussion with Glen Jameson revealed that this defoliation had occurred on earlier occasions, but that the wattles had all recovered and were expected to do so again.

Acknowledgements

Glen Jameson, Peter Kelly, Erich Sacco and members of the invertebrate survey team all helped provide information for this article.

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Addendum

On 6 December 1997 some of the *A. dealbata* were showing signs of new growth.

Australian Museum Information Discs

Produced and edited by Dr Bill Rudman

Publisher: *Australian Australian Museum, 6 College Street, Sydney, NSW 2000; Email billr@amsg.austmus.gov.au; tel (02) 9320 6125.*

Dr. Bill Rudman from the Australian Museum has developed a series of, as he describes them, 'innovative books' compressed on to a single 3.5' floppy disk. for IBM compatible computers running Windows 3.1, Windows 95 or Windows NT. The other minimum requirement for these disks is at least a VGA screen set for 256 colours. When loaded each disk occupies only 3Mb and provides you with the best screensaver I have ever seen.

I had the pleasure of reviewing four of this series:

Screensaver: Invertebrate Diversity the other 99% ($10.00)

My first attempt at loading the Screensaver disk still leaves me wondering how I loaded it. Somehow my computer and the instructions were not quite compatible but I had success and now enjoy a screen saver of not only the 42 illustrations of amazingly diverse invertebrates, but by loading the other disks all their illustrations are available as a slide show of brilliance as well. The disc Invertebrate Diversity - the other 99% also is an information disc. Illustrations and information can be printed I unfortunately do not have a colour printer, however, the detail that I printed from the illustrations was quite satisfactory.

Once I had loaded the first disk the following three were quite easy to install. From here I have enjoyed hours of pleasurable and informative reading.

Australian Cicadas by Max Moulds ($15.00)

What better time to learn about cicadas than on a hot summer evening with that deafening chorus singing outside. Did you know there are over 200 species of cicadas in Australia, and not all of them are large like the ones we lovingly collected when we were younger? This disc does not identify all the Australian cicadas, but it does identify the common ones. One small problem I encountered with this disk was that the photo sequence didn't go from left to right. The cicada life cycle photos actually went down the screen. For a younger user this could be quite confusing.

This disc would be a perfect general reference tool for any computer user and would be ideal for any school classroom. The illustrations are so clear younger learners would be able to identify their species. The information could be accessed for more advanced learners. A great section on this disk was the *Things To Do Pages*. These pages provided activities to test the learning from the disk, clubs you could join to learn more about entomology, and how to search for cicadas.

Australian Spiders by Mike Grey ($15.00)

Again, this disc would be a valuable resource to have in the home or school. I found the biology section particularly interesting. The illustration of the basic anatomical parts of the spider was also very useful to me and would be a handy tool to have beside you when you are trying to key out spiders for identification. The identification section for venomous spiders was excellent. The illustrations were very clear, and having the spiders illustrated in their habitat adds to the easy identification of the species. The information given in this section was concise and informative. Another great section was the *Webs and Webmaking* pages. Because of the clarity of the illustrations you can identify very quickly the webs of our more common groups of spiders. These illustrations and the accompanying information cannot help but make you appreciate these species even more. The sixty questions in the *Things To Do* pages really tests your memory skills. These questions range from the quite simple to the complex. All the answers are accessed by the search tool in the program.

Rocky Shore Ecology by Bill Rudman ($15.00)

This disc provided for me one of the best descriptions of seaweeds that I have read

anywhere. The illustrations were quite stunning and again allowed for easy identification. Unlike the other discs I feel the information in this program would not be easy for the younger learner. A lot of the language is more advanced and difficult to explain and addresses processes like ecological interaction. However, as a tool for the VCE Reproduction course, this disc would be fantastic. The pages on algae reproduction were excellent. Also the large number of references are extremely useful. This will prove to be very handy for those who wish to research this habitat zone further.

These discs are great value. While a book is always beautiful to have, books with this kind of information in them are expensive. These discs would be a valuable and economic option, and an excellent resource for the home or school.

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Natural History

Words distract and delight me. Especially names. As an historian of science, I am fascinated by questions about plant names, for example, why genera have received their particular names - e.g. *Acacia* or *Eucalyptus* - and why Mueller and other taxonomic authors named genera and species to commemorate particular people.

A term which has insinuated a question into my mind at odd times is ***Natural History***. The meaning of Natural is not problematical - of nature: But why History? While reviewing a fascinating historical book which includes a chapter on natural history - *Hunters and Collectors*[1] - I decided that now was the time to seek out the meaning and origin of the term Natural History.

I consulted a dictionary. *The Penguin Dictionary of Natural History* defines Natural History as:

> The study of natural phenomena, especially in the field, properly including all inanimate phenomena, such as rocks, soils and climate, but now commonly confined to living things, animals and plants in the wild.

I can understand that the scope of the Natural part of Natural History has somehow been reduced to 'living things, animals and plants in the wild'. But the question remains; why History? Several other biological dictionaries were mute on the meaning of Natural History, so I turned to that great etymological resource, the Oxford Dictionary.

One of eight entries for History in the ten volume *Oxford English Dictionary* provides an answer:

> A systematic account (without reference to time) of a set of natural phenomena, as those connected with country, some division of nature or group of natural objects, a species of animals or plants etc. Now *rare*, except in NATURAL HISTORY.

So the meaning of History in the term Natural History is 'without reference to time' - possibly a unique current meaning. *The Oxford English Dictionary* provides nine examples of writing across nearly three centuries (1567-1834) in which History is used in this sense. The first is Maplet's *A Greene Forest, or a natural Historie, wherein may bee seene the most sufferaigne Vertues in all the whole kinde of Stones and Mettals; of Brute Beastes, Fowles, Fishes [etc.]*, which was published in 1567. My interests do not generally extend quite so far back, but I shall try to remember that, in Topsell's 1608 *The History of Serpents*, Goldsmith's 1774 *History of the Earth and Animated Nature,* and Geilby's 1790 *General History of British Quadrupeds*, History carries its 'relict' meaning of 'a systematic account (without reference to time) of a set of natural phenomena' - a meaning which apparently survives today only in the term Natural History.

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[1]See book review of *Hunters and Collectors. The Antiquarian Imagination in Australia* by Tom Griffiths on p. 34 in this issue of the journal.

Colour Guide to Invertebrates of Australian Inland Waters
Identification Guide No. 8 (1997)

by John H. Hawking and Felicity J. Smith

Publisher: *Murray Darling Freshwater Research Centre. RRP $20.00.*

Over the past few decades, awareness of aquatic invertebrates in Australia has changed enormously. In the dim past, the collection and identification of invertebrates in streams and lakes was primarily the domain of visiting overseas, and a few local, scientists buried deep in Museums, struggling alone to catalogue the Australian fauna. Probably beginning in the 60's and 70's, there was a surge of local interest shown in the unique Australian fauna, and scientific research and survey projects using invertebrates became more common. Taxonomic research and keys became more common, but were still tailored to the main user groups – Universities, Museums and Government Departments.

Even more recently, interest in ecology and water has grown enormously, and the role of invertebrates in assessing river health has put them well and truely in the domain of the general public. Community groups, school groups and enthusiastic individuals armed with nets and microscopes have became part of monitoring programs like Waterwatch. Identification to at least the family level has became imperative, but identification guides were usually overly complicated (full blown scientific keys). A 'user-friendly' form of identification was needed.

The 'Colour Guide to Invertebrates of Australian Inland Waters' is designed to partially fill that gap. As a handbook for 'students, fishermen [*sic*], community based river watch personnel, amateur collectors and stream ecologists' (p. 4), it forms one of the excellent series of identification guides from the Cooperative Research Centre for Freshwater Ecology at the Murray-Darling Freshwater Research Centre in Albury.

In a handy pocket-size format (hopefully waterproof – I haven't tested it), there are 196 colour plates depicting a wide range of invertebrates, from sponges, flatworms and snails to yabbies, dragonflies and beetles. As well as a short description and photographs of most of the major freshwater families, there is additional valuable information on size, habitat, habits and broad distribution. The photographs are clear and well taken (always a difficult task for small invertebrates) and the text is basic, yet informative enough for the target audience. Selected references also lead the reader onto further information.

The guide is designed to be an adjunct to more formal keys, not as the primary source of identification. Once an identification is made from some other source (a key), it can be checked by reference to the photographs and descriptions in the book. The reader is well advised to use the guide in this manner, as not all families within an order are depicted.

The lack of inclusion of many of the invertebrate families is the main shortcoming of the book. There is no clear explanation as to why particular groups have been omitted. It is not only very rare taxa that are excluded – the commonly encountered Ptilodactylidae (Beetles) is absent – nor does it seem to be in order to conserve space – there are four photos of different genera of Gomphidae (Dragonflies) where one or two would do to illustrate the family.

I would also question the decision to provide information on selected genera within a number of families, and particularly the provision of full species names on many of the photos. As not all genera and species can be depicted, I am sure that this will lead some less experienced readers to incorrectly identify specimens to the species level simply on the basis of similarity to the photo in the book.

However, despite these shortcomings, this is an excellent and timely companion to more formal keys, which should prove invaluable, particularly for students and community-based river monitors dabbling in aquatic invertebrates for the first time. Anyone interested in the fascinating invertebrate life in Australian inland waters would also find it a valuable starting point reference. Highly recommended (but use only as directed!).

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Freshwater Algae in Australia
A Guide to Conspicuous Genera

by Timothy J. Entwisle, Jason A. Sonneman and Simon H. Lewis

Publisher: *Sainty And Associates Pty Ltd., Potts Point, NSW. 1997. ISBN 0646 31408 4. vi+242 pp. RRP Softcover $36.95, Hardcover $49.95.*

The book is designed for a broad audience of non-scientists and scientists. It is compact in size (13 × 21 cm) and divided into the following sections: Acknowledgements; Introduction; How to use this book (Schematic key, Page layout); What are Algae?; Habitats; Collecting algae; Storage and perservation (Liquid preservation, Dried herbarium specimens, Collection information); Microscopy and microscopes (Examining fresh material, Permanent slides, Microscopes); Freshwater algal management (Blooms, Weeds, Rare and threatened freshwater algae); Schematic key; Algal descriptions and illustrations; Glossary; Further information (General references on algae; Microscopic examination, staining and slide preparation; Keys and description for species); References; Index.

The authors have combined their skills and knowledge to produce a very useable guide to the 94 'most common' genera and each is given a two page spread. The left page includes the printed text with notes on: Habitat, Colour, Habit (form), Microscopic Features, Classification, Species and Distribution, Notes, Compare with (similar genera) and at the bottom are the Captions for the figures on the facing page. The captions primarily provide the magnifications for the figures. The figures are very informative and outstanding in quality. Wherever possible, colour photomacrographs of the general habit are in the upper portion of the page, and colour excellent photomicrographs at low and high magnification, often done with Nomarski optics, show the cellular details including chloroplast structure in the lower half of the page. Nearly all the photos are from living material

When suitable photographs were not available excellent black and white drawings were done (e.g. the green algae *Coleochaete*, *Schizochlamys* and *Stichococcus*).

On the right-hand margin of the photographic page for each genus is the schematic key designed to group together genera sharing key diagnostic characters. As the authors caution the reader, these do not pertain to evolutionary or taxonomic relationships. The diagnostic features should be visible with a 10× handlens or dissecting microscope. There are 13 'stick-figure' groups (e.g. non-motile single cells or compact groups of 1-4 cells, motile single cells, unbranched filaments, branched filaments, etc.) that are colour-coded for the genus shown on that page. At the bottom of the page are five yellow, colour-coded blocks indicating whether the genus is visible with the naked eye, a handlens or compound microscope, and whether it is benthic or planktonic. For each of the genera treated here, a list of references is found under Further Information on pp. 226-229.

It is questionable that some of the 'most common' genera really warrant this label. For example, the red algae *Bostrychia*, *Chroodactylon*, *Psilosiphon*, *Ptilothamnion* and the brown alga *Ectocarpus* are quite 'uncommon to rare' in freshwater within Australia *Ectocarpus* and *Ptilothamnion* have been recorded only once in one locality.

The caption and figure for *Schizochlamys* (pp. 166, 167) indicate the numerous 'flagella' but these are actually 'pseudocilia' at the apical end of the cell as stated in the section on microscopic features. The bottom photo of *Mougeotia* (p. 83) is not explained, but presumably is stained with IKI to reveal the pyrenoids ensheathed with starch.

The spread for *Chlamydomonas* includes *Haematococcus* which should really have been allocated a separate spread because it is so distinct from *Chlamydomonas* and the lumping of two diatoms (e.g. *Urosolenia/Asterionella*, pp. 56, 57; *Cyclotella/Coscinodiscus*, pp. 38, 39) in a single spread does justice to neither. The above

comments are minor and do not detract from the overall importance of this as a reference book.

The book should prove to be a best-seller around the world because it is so nicely formatted and illustrated with most genera also occurring in the Americas, Asia and Europe. It will also appeal to students in field courses for its easy use and reasonable cost.

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Eucalyptus: an illustrated guide to identification

by I. Brooker and D. Kleinig

Publisher: *Reed books, Victoria, 1996. RRP$24.95.*

Eucalyptus: an illustrated guide to identification is a unique identification text. It is not fronted with a traditional key, instead an innovative table that allows the user to easily group the 200 *eucalyptus* species covered in this book into distinct groups of species that comprise similar predominant features. Through a process of elimination, the user works through the tabulated key, using eight distinctive characters, each of which are clearly explained with words, illustrations and/or photos. These characters include bud size and position, fruits, bark type and habit. The end result contains reference numbers of several species, the digests of which complete the identification process. These digests are more traditionally formatted (of comfort to a botanist!). In addition, they include a map of the natural distribution of each species and some useful notes. The greatest benefit of this tabulated key is that the user has an increased chance of identifying eucalypts, as it only relies on eight distinctive characters (which are easily distinguished). Thus reducing the chance of the user encountering an unknown factor, which in the past (with the use of traditional keys) has left the user stranded. This tabulated key encompasses the predominant features of eucalypt identification in a simplistic way, which will be extremely beneficial to all uses alike.

However, this book has several vexatious features, the greatest of which is that it only documents 200 of the 800 eucalypt species. This could be quite frustrating for the user who is trying to identify one of the 600 not described, several of which possess similar key characters. However, a book covering an extra 600 species would add considerable cost and bulk, making it somewhat inappropriate as a field guide. In addition, the exact number of eucalypt species in Australia is currently unresolved, especially with the recent division of *Corymbia* (which has, as yet not been widely accepted). Another feature that is somewhat disconcerting at first is that the numbers in the indexes refer to page rather than species numbers.

This book makes an ideal field guide for eucalypt identification and a useful companion to the three hardback volumes of Eucalypts by the same authors. It covers the majority of the common species in each state, as well as several of the not so common species. In addition, it alludes to the important characters for eucalypt identification. The photography is excellent, although it is a pity that many species contain only photos of fruits and/or buds. This is a well-rounded field guide, which would make an ideal text for the novice, amateur, student and botanist alike.

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Seashells of Central New South Wales

by Patty Jansen

Published: *Author, Townsville, Australia 1995. RRP $40.00.*

As noted in the foreword by Dr Winston Ponder, Senior Research Scientist for Marine Invertebrate Zoology at the Australian Museum, 'it is surprising that the rich and varied fauna of the Sydney area has not inspired the production of an identification guide before now', so the realisation must have prompted Patty Jansen to provide this long-overdue publication.

Although Patty started collecting shells as a child in her native Netherlands, it was not until 1988 when she came to do a Ph.D in Agriculture at the University of Sydney that she again managed to indulge herself in this hobby. During this four-year course, the shells included in this book were collected. In 1991 and 1992, she worked as a volunteer at the Australian Museum and took a more academic interest in shells, which resulted in the publication of three papers on Australian Trochidae in 1993 and 1994. Patty currently acts as secretary of the Townsville Shell Club.

In the 114 pages of this book, Patty describes and illustates 484 species of the shelled marine molluscs most commonly found intertidally in the area surveyed, i.e., from Mallacoota in Victoria to Port Macquarie in New South Wales.

This geographic range, centred about the latitude of Sydney, provides the variety and intermingling of cool temperate water species with those found in warmer tropical waters, and this phenomenon is responsible for the presence of tropical cowry species not found further south, are figured in the text. A total of 30 tropical species has been found from Long Reef alone.

The book should have wide appeal because of the up-to-date nomenclature and excellent black and white illustrations. The text provides useful descriptions for identification of species and their biology and ecology. I appreciated the inclusion of many micromolluscs not previously included in work for popular consumption, and there is an extensive reference list of 197 entries. In spite of the glossy quality paper, I take issue with the A4 size which does not lend itself to being a companion on field excursions.

In dealing with only 'shelled' molluscs, many important families have been excluded, such as the Opisthobranchs, as well as the large bivalves which occur subtidally around Sydney and Botany Bay. Two genera of the Pinnidae, *Pinna* and *Atrina*, with three or four species, are found washed ashore after storms. *Spondylus tenellus*, although not common, was not included. The Giant Mud Oyster *Ostrea angasi*, which Patty considered to be extinct, still exists today around Sydney; it occurs mostly subtidally in spite of past records of a large population collapse. Another omission was the large Hammer Oyster *Malleus movelesiannus* occuring subtidally in the estuarine waters of Botany Bay.

In the family Ellobiidae, the drawing and description fo *Cassidula zonata* is misidentified as *Ophicardelus quoyi*.

Other members of the estuarine and brackish water families were included, such as Amphibolidae, Assimineidae and Iravadiidae, but not the Hydrobiidae which commonly occur in dense populations in estuaries and coastal lagoons, such as *Aschoris* and *Tatea*, throughout South-eastern Australia.

A very odd exclusion was the commonly occurring Polyplacaphora, the chitons so obvious throughout the entire range surveyed, particularly on rocky reefs around Sydney.

Another drawback, especially for those not familiar with molluscs, was the drawings were not to scale.

We will still need other works to supplement the short comings and omissions observed in this text. As a first-time publication covering the large number of species she collected, this is a remarkable effort for Patty to have researched, written and published the entire book herself. She deserves the recognition for this important contribution to the study of malacology in New South Wales.

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Compiled with the grateful help of Michael Shea from NSW branch MSA.

Hunters and Collectors
The Antiquarian Imagination in Australia

by Tom Griffiths

Publisher: *Cambridge University Press, 1996. RRP $34.95. Paperback, 15 x 22.5 cm, xiv + 416 pp. and 32 bw. plates.*

FNCV members blessed with long memories, and those who share my historical interest in aged issues of *The Victorian Naturalist* and other manifestations of the Club's history, may recall the name Charles Barrett and possibly also Donald Macdonald - two early FNCV members. Following the deaths of Barrett and his wife in the late 1950s, a short span of issues of *The Victorian Naturalist* (between the Septembers of 1958 and 1959) included memorial articles on both Barretts and an article in which Alec Chisholm discussed Macdonald, who had died decades earlier.

Although neither Chisholm nor the unnamed author of an earlier Victorian Naturalist article on the erection of a monument to Macdonald mentions his FNCV membership, his name is included in FNCV membership lists near the turn of the century. Charles Barrett was a much more enduring and active FNCV member, and in 1953 was awarded the Australian Natural History Medallion. At various times during the first half of this century he was librarian, committee member, president and vice-president of the FNCV, and editor of and prolific contributor to *The Victorian Naturalist*. It includes over 100 articles by Barrett and several by his wife. Barrett and Macdonald were both naturalists and writers who worked for many decades as journalists for Melbourne newspapers and who also wrote books on Victorian natural history. Their articles and books have earned them a chapter in a remarkable historical book.

Tom Griffihs' multi-award winning *Hunters and Collectors* has deservedly been widely and highly acclaimed. Griffiths skilfully weaves biographical details of selected European residents in Victoria into a vivid tapestry which portrays the shaping of European perceptions of their antipodean history in the late nineteenth and early twentieth centuries. As Griffiths notes; 'It explores historical consciousness and environmental sensibilities in European Australia.' It is an eloquent examination of the ways in which Europeans used their hunting and collection of geological and biological specimens and human artefacts and bones to construct European silences and sentiments about their place and past in Australia. According to Griffiths: It offers biographical sketches of forgotten but influential scientists and humanists, forgotten because they were 'amateurs', and influential because their commitment was to widely accessible forms of communication, such as exhibitions, collections, newspaper writings, popular books, monuments and the preservation of sites and places.

Hunters and Collectors deserves a review in this journal for three reasons. It touches on aspects of the Club's history and on past ideas about natural history in Victoria, and, in exploring wider aspects of European perceptions of the landscape and its human and faunal inhabitants, it reveals some of the political and social contexts in which natural history investigations were carried out during the first half century of the FNCV's existence. For example we learn that, as anthropological societies were being formed in Australia, in 1927 in Melbourne a Prehistorical Club was formed and soon became the Ethnological Section of the FNCV. There is no other information about this FNCV Section.

Griffiths notes that two of his collectors, the nature writers Donald Macdonald and Charles Barrett, 'have received little scholarly attention', explaining that: Their romanticism has made them marginal to the history of science, and their practical, descriptive orientation has placed them outside the study of literature and culture. Yet their commitment to ephemeral, widely distributed forms of art - the newspaper column and essay - ensured that they were to profoundly influence the popular perception of local landscape.

Originally published in *Australian Historical Studies* in 1989 with the subtitle 'The culture of nature writing in Victoria 1880-1945', Griffiths' chapter 'The Natural History of Melbourne' allows him to focuss his scholarly attention on the nature writing of Macdonald and Barrett, and to show that, as was suggested in 1908, their nature writing provides an antipodean equivalent of Gilbert White's famous 1789 *The Natural History of Selbourne*. In 1908 Bernard O'Dowd had declared: I am convinced that a 'Natural History of Melbourne', which would dwarf its great exemplar, could be written with no more material (and with no need of any more native enthusiasm for the subject) than is now to be found in Charles Barrett's 'From Range to Sea' and Donald Macdonald's regular notes in *The Argus*.

Macdonald joined the Melbourne Argus in 1881, and began preparing his reflections on nature and sketches of country life for the daily *Argus* and the weekly *Australasian*. He wrote with nostalgia about the rural charm of Keilor, where he had grown up, and described the valley's rhythms and rituals. In a wheat field he saw 'an illustration in miniature of the birth, progress and destruction of a world every summer', and discussed the place of hares, slugs, frogs, mice, quail and kestrels in that cycle. At the beginning of this century he began a new feature 'Nature Notes and Queries' in the *Saturday Argus*, which attracted a deluge of letters and specimens from across the state. Macdonald continued 'Nature Notes and Queries' and another column, 'Notes for Boys' until his death in 1932, after which a former young correspondent, Alec Chisholm, took over. I wonder to what extent Macdonald's *Argus* columns satisfied the natural history interests of rural Victorians unable to attend Melbourne or regional Field Naturalists' Club meetings.

In the 1890s Macdonald encouraged the young Barrett to write about nature and to consider it as a career. Early this century Barrett and two other nature-loving friends established a rural retreat in a hut in an old orchard on Olinda Creek, a pleasant walk from Lilydale railway station. There, named after Thoreau's 'Walden', they often welcomed Macdonald. Barrett wove observations he made at Walden and at Macdonald's bush acre at Black Rock into his first book *From Range to Sea: A Bird-Lover's Ways* (1907) and dedicated it to Macdonald 'who showed me the way'. Walden experiences also provided Barrett with material for his first published articles - in *New Idea*, *Emu*, and *The Victorian Naturalist*. Barrett's nature articles in the women's magazine, *New Idea*, superseded Macdonald's 'Glimpses of Nature'. Barrett's first article in *The Victorian Naturalist*, 'Bird life on Olinda Creek', appeared in 1906. That year, thanks to Macdonald's influence, he joined the Melbourne *Herald*. His *Herald* nature column continued for three decades and from 1925 to 1940 Barrett also edited *The Victorian Naturalist*.

Griffiths provides glimpses of the literary and social context in which Macdonald and Barrett observed and wrote about nature, and uses their experiences to reveal changing attitudes to the surrounding bush and to the hunting and collection of specimens in it. He shows how the camera increasingly replaced the gun to shoot Victoria's wildlife.

I enjoyed reading *Hunters and Collectors* from cover to cover, not in one mad rush but allowing myself one chapter at a time, sometimes sufficiently slowly to savour Griffiths' ideas and language in each eloquent paragraph. I have focussed this review on the chapter 'The Natural History of Melbourne' to remind fellow FNCV members and other readers of this journal of the writing of two early Victorian naturalists which reflected and shaped ideas about our natural environment, and of the importance of *The Victorian Naturalist* in capturing and conveying the ideas of naturalists then and now. *Hunters and Collectors* will not help you determine the taxonomic position of a beetle or bird, but it will enrich your perception of the history of Victoria's natural heritage - the opinions and organisations as well as the organisms.

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The Field Naturalists Club of Victoria

Established 1880

In which is incorporated the Microscopical Society of Victoria

OBJECTIVES: ***To stimulate interest in natural history and to preserve and protect Australian flora and fauna.***

Membership is open to any person interested in natural history and includes beginners as well as experienced naturalists.

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The Victorian Naturalist

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Vale

Ruth Clark

We regret to announce the death of Ruth Clark on 27 September 1997. Ruth was elected to the Club on 8 September 1941 as a Country member, and was made an Honourary member in 1981. She was also a member of the Bairnsdale Field Naturalists Club and contributed an article on Helmet Orchids in the area to *The Victorian Naturalist* vol. 80, 346-347, illustrated with her own drawings.

Sheila Houghton

Naturalist in Residence

We wish to thank Ian Endersby for his insights into the natural world as our most recent Naturalist in Residence.

This series continues with country members writing the articles and we are very pleased that the first author is Ellen Lyndon from Leongatha. Ellen joined the FNCV in 1943 and will be well known to a large number of our members. In this issue Ellen writes about echidnas.

Editors

Errata

In Volume **114** (6), 282-284, in the paper 'Drooping Sheoke *Casuraina verticillata* in the Mallee' by D.C. Cheal, the caption for Fig. 2. (p. 283) should read '*Casuarina verticillata* at Holland's Land (Wyperfeld National Park) - October 1995. This specimen regenerated by resprouting after the 1984/1985 fire'. The caption for Fig 3. (p. 284) should read 'Abundant seedling regeneration of *Casuarina verticillata* at Holland's Land (Wyperfeld National Park) - October 1995 - following the wildfires of 1984/1985'.

We apologise for any misunderstanding this has caused.

Editors

Thanks to:
Computer team - Alistair Evans, Anne Morton;
Label printing - Felicity Garde;
Web page - Michael McBain.

The Victorian Naturalist

Volume 115 (2) 1998 April

Editors: Ed and Pat Grey

Index to Volume 114, 1996 is in the centre of this issue

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Cover: One and a half year-old Leopard Seal 'Abyss' treated at the Melbourne Zoo after being found at Shoreham, and released 22 October 1996.

Find us on the WEB: http://calcite/apana.org.au/fncv/

A Review of Seal Rehabilitation at Melbourne Zoo 1987–1997

Kim Beasley[1]

Abstract

Three of the largest Australian Fur Seal *Arctocephalus pusillus doriferus* colonies lie on islands off the coast of Victoria and, of the 53 seals Melbourne Zoo has received for rehabilitation in the last ten years, most were Australian Fur Seals in varying states of ill-health. 23 seals have so far been released and seven have been resighted. Keeper time represents the programs' greatest expense. (*The Victorian Naturalist* **115** (2), 1998, 40-46).

Introduction

Since 1987, when a rehabilitation program for seals was established, 53 animals have been brought to Melbourne Zoo with most suffering from a range of injuries, health problems and starvation. Included in this number are 11 animals which were dead on arrival, too ill or weak to survive transportation, and 15 seals which died or underwent euthanasia when their prospect of recovery or long-term survival was deemed hopeless. A further four seals which recovered, but were unsuitable for release have become part of captive collections. Twenty-three seals have so far been successfully released.

Except for those seals presenting with injuries from such things as boat propellers, gun-shot wounds and entanglement in plastic debris, these deaths would have formed part of the natural mortality of the species. Rehabilitating and releasing such animals has no beneficial impact on the wild populations. All releases are potentially deleterious to wild populations because of the risk of introducing pathogens into them via released animals; hence rigorous veterinary examination and quarantining are essential. The reverse is also true and, to protect captive stock from diseases and parasites, wild seals have no contact with the zoo stock.

Species

Victorian coastal waters are inhabited by the Australian Fur Seal *Arctocephalus pusillus doriferus* which has a total population presently estimated at 47,000–60,000 (Pemberton and Kirkwood 1994). Three of the largest breeding colonies are situated off the Victorian coast: Seal Rocks 2km off Phillip Island, Lady Julia Percy Island near Port Fairy and Kanowna Island off Wilsons Promontory (Warneke 1982). New Zealand Fur Seals *Arctocephalus forsteri*, southern seals such as Leopard Seals *Hydrurga leptonyx*, Subantarctic Fur Seals *Arctocephalus tropicalis* and Elephant Seals *Mirounga leonina* are all occasional visitors. In the last ten years the zoo has received three Leopard Seals, five New Zealand Fur Seals, seven Subantarctic Fur Seals and 38 Australian Fur Seals. Seal pick-up sites are shown in Fig. 1.

Reasons for Seals Coming to the Zoo

Most of the seals received have been Australian Fur Seal yearlings, which were severely underweight. Their arrival between November and January overlaps the breeding season in November/December when the cows give birth and abandon the previous season's pup which must then live fully independently. Some of those yearlings, which may be less skilled at finding food, are found hauled out on beaches around the State in an emaciated and dehydrated condition.

The boundaries of the Southeast Fishery which stretches from the waters off Sydney southwards around Tasmania to

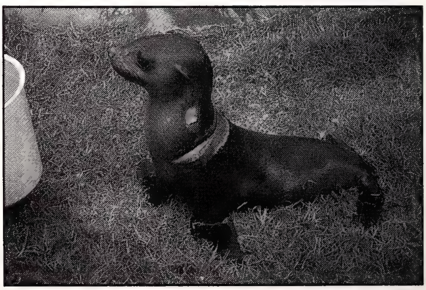

Fig. 2 Chopper's neck wound was the result of a loop of baling twine.

[1] Melbourne Zoo, P.O. Box 74, Parkville, Victoria 3052.

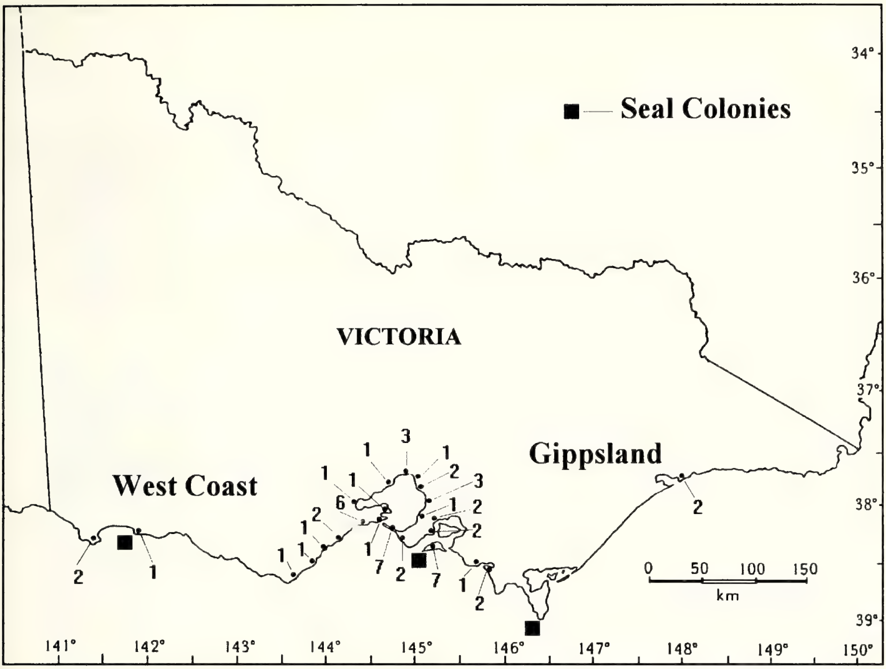

Fig. 1. Seal collection sites. The site to the west of Port Phillip Bay from which six animals were collected is a wildlife shelter at Barwon Heads.

Kangaroo Island in South Australia (McLoughlin *et al.* 1994), potentially places fishing vessels in direct competition with seals for the 16 major commercial fish species taken in this area. The variety of fish found in the stomachs of Australian Fur Seals or seen to be taken from nets includes at least 20 species and in general they appear to be opportunistic feeders (Warneke and Shaughnessy 1985).

Entanglement in discarded nets, fishing line, baling twine and plastic refuse represents another hazard for the seals of this region. The longevity of these items ensures that their lethal potential will continue for many years. The zoo has received five seals with entanglement injuries (Silva, Webby, #22, Chopper (Fig.2), and Mac), but many more have been found dead, or have disappeared back into the ocean before they could be caught. Death for most results from infection, strangulation as the seal grows, or starvation when the increased drag makes it an ineffective hunter. A range of other serious health problems has also been observed in seals brought to the zoo (Table 1).

The Rehabilitation Program

The reason for maintaining a seal rehabilitation program lies in a commitment to animal welfare on the part of Melbourne Zoo, the Department of Natural Resources and Environment and the community as a whole. The support of residents and local police at seal 'strandings' as well as media coverage of seal captures and releases is evidence of this interest. Whilst the benefits to the zoo of positive public relations are important, the experience gained by marine mammal staff in all aspects of rehabilitation and husbandry has also been invaluable.

Seals are usually caught in a hoop net then transferred to a well-ventilated cage for transport to the zoo. After a veterinary examination and any required treatments marine mammal keepers weigh each seal received, formulate a suitable diet and feeding regime, then maintain detailed records of food intake, growth, behaviour, treatments and general condition. Without complications most animals start to put on weight rapidly and reach a suitable weight for age at around 6–8 weeks. Each has been branded, tagged (Fig. 3) or both prior

Table 1. All seals received by Melbourne Zoo from December 1987–JDecember 1997
Species:AFS=Australian Fur Seal, NZFS=New Zealand Fur Seal, SAFS=Subantarctic Fur Seal, LS=Leopard Seal
Age:Animal ages were determined upon examination of dentition, body length, colouration of pelage and time of year.
Flipper tags:ff=front flipper; hf=hind flipper ; m.c.= micro-chip.
Cause of death:D.O.A.=dead on arrival.

Date	Sex	Species	Condition	Age	I.D.	From	Flippertags	Fate	Cause
08/12/87	M	AFS			Maurice	Beaumauris		Died-13/12/87	Meningitis & spinal abscess.
30/07/88	F	AFS	Poor	1yr	Silva	Sorrento		Captive	
25/11/88	F	AFS	Poor		Jirra	Barwon Heads		Died-3/12/88	Abdominal wounds
11/01/89	M	AFS	Good	1yr	Gordon	Barwon Heads	Brand-'T'both flanks	Released-22/02/89	
23/01/89	F	AFS	Poor		One-eye	Barwon Heads		Died-31/01/89	Internal bleeding.
26/05/89	F	AFS	Poor	6mth	Julia	Portland		Captive	
02/08/89	F	AFS	Good	8mth	Dyson	Frankston	Brand-'V'both flanks	Released-31/08/89	
20/10/89	F	SAFS	Fair		Troppo	Altona		Died-27/10/89	Enteritis
31/12/89	F	AFS	Fair	4mth	Rhyll	Phillip Is.		Died-7/04/90	Bronchopneumonia
05/01/90	M	NZFS			Forster	Port Melbourne		Died-14/01/90	Acute broncho pneumonia
15/01/90	M	AFS			#11	Chelsea Beach		Died-15/01/90	D.O.A.Gunshot wound
29/07/90	F	NZFS	Poor		Skerry	Edithvale	Brand.-'I'flanks/ Tags A46 & A47	Released-11/12/90	
20/08/90	M	AFS			#13	13th Beach		Died-20/08/90	D.O.A.
21/09/90	M	AFS	Fair	10mth	Barwon	Barwon Heads	Brand.-'E'flanks/ Tags A45 & A44	Released-17/11/90	
28/09/90	M	SAFS	Fair	1.5yr	Apollo	Apollo Bay		Died-7/10/90	Acute viral gastroenteritis
30/10/90	M	AFS			#16	Werribee		Died-30/10/90	D.O.A.-gunshot wounds
10/12/90	M	AFS	Fair	1yr	Wilson	Venus Bay	Tags-L ff-A49 R ff-A48	Released-14/03/91	
30/01/91	M	AFS			#18	Point Lonsdale		Died-30/01/91	D.O.A.HeadWounds
23/05/91	M	AFS			#19	Phillip Is.		Died-23/05/91	D.O.A.-pneumonia
26/07/91	M	AFS			#20	Mordiallic		Died-26/07/91	D.O.A.-pneumonia
11/08/91	F	SAFS	Poor	1.5yr	Safs	Phillip Is.		Died-07/01/92	Euthanised.Eye disorders
11/08/91	M	SAFS			#22	Cape Patterson		Died-11/08/91	D.O.A.Entanglement
06/09/91	M	AFS	Poor		#23	Phillip Is.		Died-06/09/91	D.O.A.-Starvation

Table 1. cont.

Date	Sex	Species	Condition	Age	I.D.	From	Flippertags	Fate	Cause
24/11/91	F	AFS			#24	Lorne		Died-24/10/91	D.O.A.-Bronchitis
19/11/91	F	AFS	Fair	1yr	Coral	Barwon Heads	Tags-L ff-Z03 R ff-Z04	Released-07/04/92	
20/11/91	M	AFS			Jelly	Williamstown		Died-24/11/91	Abscess to flipper
26/11/91	M	AFS			#27	Blairgowrie		Died-26/11/91	D.O.A.Severe wounds.
29/12/91	F	AFS	Good	1yr	Cribby	CribPoint	Tags-L ff-Z00 R ff-Z02	Released-07/04/92	
22/01/92	M	AFS	Poor		#29	Barwon Heads		Died-23/01/92	Euthanised-very poor condition
12/03/92	M	AFS	Poor		#30	Sorrento		Died-12/03/92	D.O.A.-poor condition
26/05/92	F	AFS	Fair		Cribby	Crib Point		Re-released03/07/92	
21/06/92	F	NZFS	Good	1.5yr	Webby	Port Melb.	Tags-L ff-Z06 R ff-Z07	Released-03/07/92	
22/07/92	M	LS	Poor	1.5yr	T'Rex	Phillip Is.		Died-31/07/92	Severe enteritis.
14/08/93	F	LS	Poor	1.5yr	Fliptop	Janjuc	Tags-L hf-G88 R hf-G89	Released-29/09/93	
12/12/93	M	AFS	Poor	1yr	Schanck	Cape Schanck		Died-19/01/94	Congenital liver abnormality.
20/01/94	M	AFS	Good	1yr	Porty	Portland	Tags-L ff-Z14 R ff-Z15	Released-04/03/94	
12/09/94	M	NZFS	Fair	1yr	Lieu	Lakes Entrance	Tags-L ff-Z16 R ff-Z17	Released-22/11/94	
15/11/94	F	AFS	Fair	1yr	Rosie	Sorrento	Tags-L ff-Z18 R ff-Z19	Released-16/12/94	
26/12/94	F	AFS	Fair		Rosie	Wye River		Re-released-12/01/95	
26/01/95	F	AFS	Fair		Rosie	Balnarring		Captive	
07/02/95	M	AFS	Good	2yr	Cass	Newhaven	Tags-L ff-Z20 R ff-Z21	Released-01/03/95	
11/02/96	F	AFS	Poor	>8yr	Woody	Elwood		Died-17/02/96	Liver cancer
27/02/96	M	AFS	Good	1yr	Chopper	Hastings	Tags-L ff-Z22 R ff-Z23	Released-25/03/96	
14/08/96	F	SAFS	Fair	1.5yr	Mac	Port Arlington	Tags-L ff-Z24 R ff-Z25	Released-03/10/96	
16/09/96	F	LS	Fair	1.5yr	Abyss	Shoreham	Tags-L hf-G93 R hf-G94	Released-22/10/96	
10/10/96	F	SAFS	Fair	1yr	Crozet	Port Fairy	Tags-L ff-Z26 R ff-Z27	Released-09/12/96	
02/12/96	M	AFS	Good	1mth	#44	Phillip Is.		Died-02/12/96	Euthanised
03/12/96	M	AFS	Poor	1yr	Hastings	Hastings		Died-09/12/96	Severe bronchial pneumonia
04/01/97	M	AFS	Good	1yr	Matt	Gunnamatta	Tags-L ff-Z28 R ff-Z29	Released-31/01/97	
15/01/97	M	AFS	Fair	2yr	Bass	Torquay	Tags-L ff-Z30 R ff-Z31	Released-10/02/97	
17/6/97	F	NZFS	Fair	1.5yr	Lois	Beaumauris		Trans. to Seaworld	
5/8/97	F	SAFS	Poor	1.5yr	Georgia	Lakes Entrance		Died - 11/08/97	Haemorrhagic enteritis
23/9/97	F	AFS	Fair	10mth	Tyrone	Blairgowrie	Tags - L ff-Z32 Rff-Z33	Released-26/11/97	
18/11/97	M	AFS	Fair	1yr	Capel	Rye Beach	Tags - Lff-Z34 Rff-Z35 m.c.	Released-03/12/97	
6/12/97	M	AFS	"	"	Capel	San Remo		Re-released-07/12/97	
18/11/97	F	AFS	Good	1yr	Aussie	Geelong	Tags - Lff-Z36 Rff-Z37 m.c.	Released - 03/12/97	
21/11/97	F	AFS	Poor	1yr	Nabs	Rosebud	Tags - Lff-Z38 Rff-Z39 m.c.	Released - 30/12/97	

to release and seven have been re-sighted in good condition some months later. A release location is selected, usually at the seal colony nearest the pick-up site and preferably from a boat.

Facilities

Seals being force-fed, undergoing intensive veterinary care or being held during severe weather conditions are maintained in one of the enclosures within the animal hospital building. Self-feeding animals are later maintained in an outdoor yard approx. 5×7 m in size. Substratum of the primary yard consists of grass with a small 2×1 m concreted area. A shallow pool, with a maximum depth of 35 cm, encompasses a third of this yard; salt is added to the pool to assist in maintaining water quality, when required. Shade cloth provides protection from the sun and the animals also have access to a large freestanding wooden box. A sprinkler is available in hot, dry conditions. One of two adjoining yards, similar in size, is used when a second animal is received. This is a grass-covered yard in which a fibreglass pool can be installed.

Results

Table 1 presents the details and fate of the 53 animals received by the zoo. Three seals were returned after a release. One of these (Rosie) subsequently joined the zoo's captive population after a second and then a third return to the zoo. She had followed people for food each time, this being the reason for her pick-up initially. Another (Cribby) was released at Yarrum, but returned to Crib Point where she had previously sought fish from local anglers. She was subsequently released at Port Fairy. Seven seals (Gordon, Dyson, Barwon, Wilson, Matt, Chopper and Bass) have been resighted after release, all in good condition.

Fig. 3. Coral is positioned on the restraint board for flipper tagging.

Table 2. Feeding methods and daily costs. The cost is based on the 1997 rate of $15.60/hour.

Feeding Method	Hrs/Day	Cost
Type A		
Force-feeding using 3 keepers × 3 feeds @ .5 hrs/feed	4.5	
Seal weighing 10 mins/day	0.16	
Transit time to and from vet department – 20 mins/day	1.0	
Total	**5.66**	**$88.29**
Type B		
Force-feeding using 2 keepers × 3 feeds @ 20 mins/feed	2.0	
Seal weighing 10 mins/day	0.16	
Transit time	0.7	
Total	**2.86**	**$44.61**
Type C		
Self-feeding - 1 keeper × 3 feeds @ 20 mins/feed	1.0	
Seal weighing 10 mins/day	0.16	
Transit time	0.35	
Total	**1.51**	**$23.55**

Costs

Seal rehabilitation is often an expensive process. Staff time and the associated cost of treating, housing and maintaining sick and injured animals can be considerable. A major component of the cost is keeper time. After the initial periods of veterinary examinations and treatment, keeper time allocated to the animal depends on the feeding method required. Yearlings have generally required a short period of force-feeding before accepting dead fish willingly. Typically this has taken several days, but there were occasions when force-feeding lasted for longer periods.

The initial feeding method (Table 2; Type A, Figs. 4, 5) is force-feeding under full restraint and requires 3 keepers, two to restrain the animal and open its mouth, the third to feed. This method is the most costly. As the seals become accustomed to eating dead fish, on land, they offer less resistance and can be restrained by one keeper (Type B). Fish is always offered without restraint first, so that as soon as food is taken willingly, force-feeding is discontinued and only one person is required (Type C). Once a seal takes fish which are thrown into the pool all keeper/seal interaction is kept to a minimum to decrease the likelihood of imprinting. Each animal is weighed several times a week, if possible, to monitor their progress.

Table 3. Detailed costings for example animals. Costings do not include veterinary time or treatments.

Year	Species	I.D.	Days In Zoo	Food (kg)	Cost ($)	Feeding Method Type A	B	C	Capture/ Release	
1989	AFS	Gordon	32	172	259	$163		$2,446	$173	**$3,040**
1989	AFS	Dyson	29	102	153	$571	$41	$458	$115	**$1,338**
1990	AFS	Rhyll	97	Milk Formula	865		$742	$1,718		**$3,325**
1990	AFS	Wilson	94	216	324		$350	$1,859	$173	**$2,706**
1991	AFS	Coral	139	231	347	$489	$206	$2,784	$173	**$3,999**
1993	L.S.	Fliptop	46	580	928			$1,116	$316	**$2,360**

Fig. 4. Webby being force-fed, using towels to open the mouth..

Fig. 5. Webby being force-fed without the towel. After this the animal will be eating on its own.

Food does not usually represent the major expense since most animals successfully rehabilitated spent only 1–3 months at the zoo, eating between 50–200kg of fish. The two released leopard seals, on the other hand, required 500–600kg of fish each to restore body condition. Table 3 shows some examples of keeper time and food cost breakdowns for a number of animals.

Diet

Seals undergoing rehabilitation were provided with a diet similar in composition to that provided to zoo animals. As much variety as possible was offered and species included Whiting *Sillago flindersi*, Pilchards *Sardinops neopilchardus*, Yellowtail Mackerel *Trachurus novaezelandiae*, Tommy Rough (Herring) *Arripis georgiana*, Goatfish *Upeneichthys vlamingii*, Mullet *Myxus elongatus*, Squid *Nototodarus sloanii*, Blue Mackerel *Scomber australasicus*, Blue Warehou *Seriolella brama* and Trumpeter *Pelates octolineatus*. Daily vitamin supplements were also added to the fish.

Live fish were used on occasion to encourage foraging/hunting behaviour. One seal would not accept dead fish willingly even after an extended period of force-feeding. It appeared that he would not progress to 'self-feeding', until live fish were introduced into the pool. He immediately caught and ate them, this being the only interest he had shown in eating. Although we had tried to tempt him by throwing dead fish into the water before, from this point on he ate everything that was offered, dead or alive.

Examples of individual cases.

Example 1 (Fig. 6)

The female Australian Fur Seal, Dyson, arrived at age 1.5 yrs in fair condition. Weekly food intake regularly exceeding body weight is common in young fur seals undergoing rehabilitation. The sharp decrease in appetite (in week 4) is a general clue to timing the release of a healthy seal. Dyson was received on 2/8/89, released on 31/8/89 and resighted at Seal Rocks in November 1989

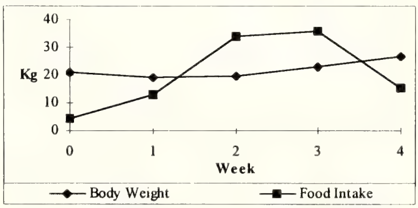

Fig. 6. The female Australian Fur Seal Dyson.

Example 2 (Fig. 7)

The yearling, male Australian Fur Seal, Wilson, was underweight when received by the Zoo. His food intake fluctuated but he maintained a steady weight increase throughout. He was released on 14/3/91 and resighted on Seal Rocks on 22/11/91.

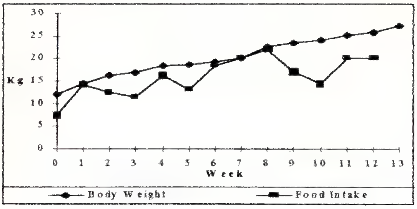

Fig. 7. The male Australian Fur Seal Wilson.

Example 3 (Fig. 8)

Fliptop, a female Leopard Seal was approximately 18 months old when she arrived in poor condition on 14/8/93 weighing 96.5 kg. In five weeks she almost doubled in weight and was released outside Port Phillip Heads on 29/9/93 weighing 182.6 kg. She ate an average of 15 kg of fish per day and has not been resighted after release.

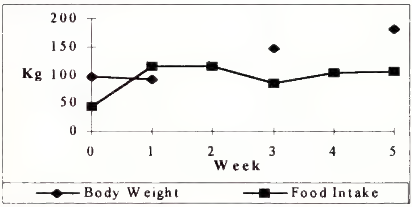

Fig. 8 Fliptop, a female Leopard Seal

Conclusion

Despite the cost of treating and maintaining these seals, the benefit of the seal rehabilitation program to the Marine mammal department has been considerable. The additional experience in capture and restraint, force-feeding, observing and assisting with veterinary procedures, nutrition and dealing with a variety of seal species has been invaluable. There is no other facility in Victoria equipped to provide sick or injured seals with the care and expertise that they require.

In the future we would like to use satellite tracking to monitor the progress of one or two rehabilitated seals, ideally an antarctic or subantarctic specimen and later possibly an Australian Fur Seal of suitable size. The data collected would give us an understanding of each animal's activity and movements after release. In particular it would be of interest to find out whether rehabilitated Subantarctic Fur Seals succeed in returning to their normal range in the southern ocean.

Acknowledgments

Thanks to the Melbourne Zoo Veterinary department and Karen Svalesen for their valued assistance and Angus Martin for reading the manuscript.

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Rubber and Plastic Rubbish: A Summary of the Hazard Posed to Platypus *Ornithorhynchus anatinus* in Suburban Habitats

Melody Serena[1] and Geoff A. Williams[1]

Abstract

Over the period November 1989 to January 1998, 133 Platypus were captured along six representative waterways around Melbourne. Of these, 14 animals (10.5%) were entangled by litter, including fishing line, elastic bands, a rubber canning jar seal, an engine gasket seal, and a plastic sealing ring from a commercial food jar. Potentially life-threatening injuries were caused by nylon fishing line and the plastic sealing ring. (*The Victorian Naturalist* **115** (2), 1998,47-49)

Introduction

A variety of marine animals have been recorded to become entangled in plastic rubbish, including gulls, pelicans, penguins, seals and dolphins. We report here on the incidence of entanglement of a freshwater mammal, the Platypus *Ornithorhynchus anatinus*, by plastic and rubber debris along several waterways passing through suburban areas around Melbourne.

Study methods

Records of litter entwined around Platypus were obtained as a by-product of population surveys or mark-recapture studies undertaken from November 1989 to January 1998. The Platypus were captured in fyke (or eel) nets, which do not entangle the animals in folds of netting. Instead, animals are directed by a series of netting funnels to enter a non-return chamber. To ensure that Platypus do not drown, the main body of the net is suspended partly out of the water by securely attaching the end of the non-return chamber to a metal stake. The nets are set in pairs in the afternoon, with one net facing upstream and the other facing downstream, and checked at regular intervals through the night. To minimise the likelihood that a Platypus travels past a net without getting captured, two mesh wings flanking the main body of the net are stretched across the entire width of the channel, and gaps between the net and substrate are eliminated by weighting the bottom edge of the wings with rocks.

Each captured Platypus is inspected, weighed, and permanently marked, using a Trovan microchip transponder implanted just under the skin between the shoulder blades (Grant and Whittington 1991). Sex and age class are assigned according to spur characteristics, enabling juveniles (<12 months) to be distinguished from older (adult or subadult) animals (Temple-Smith 1973).

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Results

Pieces of plastic or rubber litter were removed from animals living along six waterways in the Yarra River, Werribee River and Dandenong Creek catchments (Table 1).

Diamond Creek (Yarra River catchment). Of eight animals captured from 1995 to 1997 in Eltham township, three juveniles had litter looped around the neck or torso. These included two young females, each carrying a wide elastic band around the neck, and a young male with an elastic band strung diagonally around the torso from the left shoulder to behind the right foreleg.

Mullum Mullum Creek (Yarra River catchment). Of 22 animals captured from 1995 to 1997 in the Melbourne suburbs of

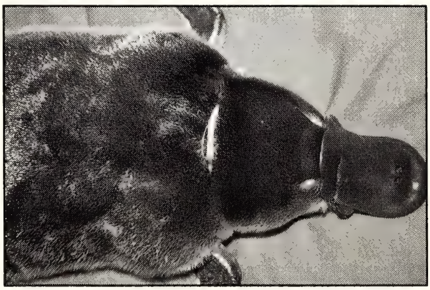

Fig. 1. Adult female platypus carrying a loop of nylon fishing line and an elastic band around the neck.

Table 1. Incidence of Platypus found entangled by litter in the Yarra River (YR), Dandenong Creek (DC) and Werribee River (WR) catchments.

Waterway	No. of animals captured	No. of animals entangled (%)	Period of capture
Diamond Creek (YR)	8	3 (37.5%)	1995-1997
Mullum Mullum Creek (YR)	22	3 (14%)	1995-1997
Watts River (YR)	22	3 (14%)	1991-1994
Badger Creek (YR)	45	1 (2%)	1989-1994
Monbulk Creek (DC)	30	2 (7%)	1996-1998
Werribee River (WR)	6	2 (33%)	1997-1998
Total	**133**	**14 (10.5%)**	**1989-1998**

Templestowe and Doncaster East, three individuals had a piece of rubbish entwined around them. These included an adult female carrying a 10 mm-wide loop of elastic ribbon (probably derived from a garment cuff) around the neck, and a juvenile female carrying a wide elastic band diagonally around the torso from the right shoulder to behind the left foreleg. A second adult female had a large elastic band caught around the neck in February 1995, and another elastic band caught around the same part of her body in December 1997. All three animals were captured downstream of Reynolds Road.

Watts River (Yarra River catchment). Of 22 animals captured from 1991 to 1994 between Maroondah Dam and the downstream end of Healesville township, three adults or subadults had pieces of litter caught around the neck. These included a male carrying a flexible rubber ring of unknown origin, a male carrying both an ordinary elastic band and a rubber canning jar seal, and a female carrying an elastic band and a loop of nylon fishing line (Fig. 1). The fishing line had cut deeply into the animal's skin under the neck, creating a lesion 3–4 mm wide. As well, an adult female captured along this waterway had a recently healed scar located under and around one side of the neck, consistent with injury due to a narrow material such as fishing line or wire. Three of the animals were encountered within a short distance of the Healesville town centre, while the fourth Platypus was captured about 1.5 km upstream.

Badger Creek (Yarra River catchment). Of 45 animals captured from 1989 to 1994 between Don Road and Dalry Road in the outskirts of Healesville, one juvenile female had an elastic band wrapped around the chest. As well, an adult female in this area had a wide scar across the right shoulder and neck, along with a second prominent scar just behind the left foreleg, consistent with injury by material looped diagonally around the body.

Monbulk Creek (Dandenong Creek catchment). Of 30 animals captured from 1996 to 1998 between the Clematis Creek confluence and the Ferny Creek confluence, one juvenile male carried a rectangular rubber gasket seal, probably from a motor vehicle engine, looped around the torso diagonally from the right shoulder to behind the left foreleg. In addition, a grown female had a wide elastic band caught around the torso diagonally from the left shoulder to behind the right foreleg. The two animals were encountered respectively in Lysterfield (about 1 km upstream of Lysterfield Road) and Belgrave (0.1 km upstream of Belgrave Lake).

Werribee River (Werribee River catchment). Of six individuals captured within Werribee township from December 1997 to January 1998, one adult or subadult female carried an elastic band wrapped diagonally around the torso from the left shoulder to behind the right foreleg. As well, the same animal carried a yellow plastic ring (of the type used to make a tamper-proof seal around the mouth of plastic-lidded glass food jars) diagonally around the torso from the right shoulder to behind the left foreleg. The rough edge of the ring had cut deeply into the skin just behind the leg and the left front foot was badly swollen. Three other animals (including an adult male and two adult or subadult females) were observed to have narrow bands of scar tissue around the base of the neck; in the case of the male, a

disintegrating piece of fishing line was found adhering to the site of the recently healed injury.

Discussion

Like marine mammals and birds, the Platypus appears to be vulnerable to becoming entangled and sustaining injuries after encountering rubbish. In addition to the examples recorded in our field studies, the following materials have been reported to be problematic to the animals: a single loop of fishing line caught around the chest of a Platypus found on the banks of Lake Learmonth near Ballarat (Serena 1993); a single loop of fishing line caught around the neck of a Platypus along the Yarra River at Ivanhoe East (Museum of Victoria database); the loops of a plastic 6-pack carrier shackling the front and back limbs of a Platypus beside the Yarra River at Warburton (Australian Platypus Conservancy database) and a section of one-inch PVC pipe wedged around the neck of a Platypus along a waterway near Benalla (Serena 1993). In all four of these cases, the animals were dead or dying when discovered.

Rubbish presumably is most likely to become caught around a Platypus as the animal forages underwater, using a lateral 'wagging' motion of the head to search systematically along the bottom for prey or probe more intensively in sediment or under rocks once prey is detected (Scheich *et al.* 1986). In this study, most items of rubbish carried by the animals (n = 18) either encircled the neck (61%) or were wrapped diagonally from one shoulder to behind the opposite foreleg (33%). The Platypus may find it difficult to remove such objects in part because the highly specialised front foot is furnished with a broad web of skin that acts as a paddle in the water (Burrell 1927); the Platypus consequently relies on its hindlimbs and bill for grooming (*unpubl. data*).

All of the items found to be entangled around animals in this study took the form of closed loops, ranging from 13 – 24 centimetres in circumference (18.1 $\pm$ 2.9 cm, mean $\pm$ S.D., n = 12). While objects fabricated from rubber (elastic bands and ribbon of various widths, a canning ring seal and a gasket seal) appeared to be relatively innocuous to the Platypus carrying them, those fabricated from plastic (nylon fishing line and a ring seal from a glass jar) were responsible for potentially life-threatening injuries.

Recommendations

1. To reduce the risk posed by rubbish to Platypus and presumably other wildlife species, manufacturers should incorporate an easily broken weak link into the design of small to medium-sized plastic loops, whenever this is consistent with their primary function.
2. As well, consumers should endeavor to sever plastic loops or rings of any size before disposing of them, and members of the public should make a special effort to remove these items from the environment when they have been discarded as litter.

Acknowledgments

We are particularly indebted to Melbourne Water, the National Geographic Society, VicRoads and the Mullum Trust for helping to fund Platypus studies near Melbourne. Permission to capture and handle Platypus was provided by the Department of Natural Resources and Environment (Wildlife Research Permits RP-89-167 through RP-96-244 and Fisheries Permit FSP-CW-107).

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Glenburn Pond: an Urban Revegetation Project

Kathleen Ralston[1] and Elaine Moir

Abstract:
This paper reports on the study and revegetation of a small urban constructed wetland near Gardiners Creek, Glen Iris, from February 1994 to February 1996. during which time records were kept of the existing plants, revegetation details, weed eradication methods, waterlife and natural occurrences. (*The Victorian Naturalist* **115** (2), 1998,50-55).

Introduction

This paper reports on the study and revegetation of a constructed seasonal wetland, conducted between February 1994 and February 1996. During this time the authors recorded the natural occurrences, conducted a survey of plants, revegetated the site, trialled weed eradication methods and regularly sampled waterlife.

The paper is presented so that others will learn from our successes and failures and will feel confident to take on similar urban wetland projects.

Description of the Site

Glenburn Pond is situated in Glenburn Park, near Gardiners Creek, Glen Iris, (Melway ref: 59J7) and forms part of a linear parkland in Public Open Space managed by the City of Stonnington (previously the City of Malvern). The site is 46 metres long (north/south) and 14 metres wide (east/west) and was formed when the Council bulldozed a natural depression into a slightly deeper channel.

Many studies of the area (Waddell 1956; Muir 1976; Bridgewater and Wellington 1976) indicate that the original vegetation was dominated by trees such as Swamp Paperbark *Melaleuca ericifolia* and Swamp Gum *Eucalyptus ovata* and grasses such as Kangaroo Grass *Themeda triandra* and *Poa* species.

Hall (1911) described how the area had already been modified:

> The thick teatree scrub has been cut down, though not so very long ago it was dense even down to Burnley. The water from Surrey Hills, Canterbury and East Camberwell is hurried into the creek through paved drains, and every swamp has a trench cut from it. The result is that a heavy shower swells the creek to a raging flood, and as the protecting scrub with its binding roots is gone there is nothing to prevent the loose alluvium from disappearing at a marvellous rate.

Getting Started

The authors first met at a Friends of Gardiners Creek Valley Inc. (the Friends) planting day in September 1993 and we wondered aloud 'what happens when a bulldozer digs a hole and it is left to fill with water?'. This wondering was the beginning of our two-year project.

Our knowledge of plants and wetlands was meagre so we joined The Field Naturalists Club of Victoria (FNCV). At our first FNCV Botany meeting on 14 February 1994 a decision was made to identify sites around Victoria as permanent study sites. The newly formed FNCV Botany Research Group accepted Glenburn Pond as a suitable study site. The City of Malvern approved our two-year project and also agreed that no work would be carried out by Council staff in the immediate area of the study site without first notifying the Friends.

Throughout the study period we attended various courses on plant identification and wetland and riparian revegetation and visited numerous other wetlands, constructed and natural.

Aims of the Project:

The major aims of the proposed two year study were to:

- record the natural occurrences;
- revegetate the area with indigenous plants;
- protect the indigenous species from environmental weeds;
- prepare a 'qualitative case study' research paper for publication.

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Methods

Recording System

This consisted of a field notebook each. On each of our 3-hour weekly visits we recorded air and water temperature, depth of water, any natural (or unnatural) occurrences and the revegetation work we carried out. Each month we photographed the site from the same positions and took photographs whenever something unusual happened, such as damage by storm or vandals.

Survey of Existing Flora

When we began the study in February 1994 the Council had sprayed the area with herbicide, except for two small plots that had been left because it was thought they contained indigenous plants. The Friends had already mulched some of the area and planted approximately 50 plants, but the major part of the site was untreated and unplanted (Fig. 1).

We asked The FNCV Botany Research Group for assistance with plant identification, and John Stewart visited the site in April 1994 and identified the existing plants – 21 indigenous plants and 25 weed species (marked with # in Appendix 1 and 2). He offered advice on how to tackle the weeds.

A number of fungi species appeared in the first year, but Tom May of the FNCV and National Herbarium indicated that these species, *Agrocybe*, *Tubaria* and *Volvariella,* appear on woodchip mulch and they would be less prolific each year as the mulch decomposed. This proved to be the case.

Revegetation

We used the *Flora of Melbourne* (Society for Growing Australian Plants, Maroondah, Inc., 1993) as our major reference of what to plant, and where, taking particular note of plants indigenous to the area and their likelihood of survival in both water inundation and desiccation.

The only indigenous plants to appear during the study period were Common Spikerush *Eleocharis acuta*, Slender Knotweed *Persicaria decipiens*, Willow Herbs *Epilobium* species, Knob Sedge, *Carex inversa* and *Geranium* species.

The major cover was environmental weeds and the weed eradication methods we applied included: hand removal and plant replacement; newspaper and mulch; jute weedmat and mulch; removing flowering heads; and limited herbicide spraying.

Hand removal, beginning in the least affected area and slowly moving towards the worst infested area, was the most successful method in areas where indigenous plants were becoming established. We combined this method with that of replacing the weeds with indigenous plants. This worked extremely well when we used Tussock Grass *Poa sp.*, which spread out and shaded the ground, restricting the growth of weeds.

Newspaper and mulch was an effective method with large expanses of weeds. The weeds did not need to be removed before laying newspaper and mulch, but we did brush-cut tall, strong-stemmed weeds. Initially we did not use enough layers of paper, or sufficiently overlap the edges, and the weeds pushed through the gaps (Fig. 2). Eventually we found that a thickness of at least 10 sheets of newspaper, carefully overlapped by at least 10 cm, followed by 12-15 cm mulch, successfully thwarted most weeds. We also began to use newspaper and mulch around new plants to discourage the weeds.

We did not use plastic weedmat as we had already seen the evidence of plant

Fig. 1. Glenburn Pond, east to west, 26 September 1993.

Fig. 2. Weeds growing through insufficiently overlapped newspaper.

choking and the difficulty of its removal, but we trialled a commercial jute weedmat. This had limited success as it repressed the Drain Flat Sedge *Cyperus eragrostis* but, even with a double layer, the Couch Grass *Cynodon dactulon* came through.

Removing seeding heads to protect both the study site and the surrounding areas was an approach we took when we did not have the time to remove the weed and replant. This approach was reasonably successful, but some plants resprouted and became even stronger after deheading, particularly Aster Weed *Aster subulatus*.

We were loathe to use Glyphosate, commonly known as Round-up or Zero, anywhere near the water as research indicated that either Glyphosate itself, or the surfactant used, could have a detrimental effect on waterlife (Durham 1993). But, in March 1995, when the pond had been completely dry for four months, we used herbicide on the Couch Grass, which had defeated all tried methods of control. A few weeks later we planted indigenous plants in the same area and most have survived well.

By the end of the two years we had identified more than 50 weed species (Appendix 1) and had planted more than 70 species of indigenous plants (Appendix 2). The most difficult weeds to eradicate were Drain Flat Sedge, Couch Grass , Docks *Rumex* species and White Clover *Trifolium repens*. Of the 70 species planted, the best survivors were the grasses, rushes and sedges. All the *Juncus* and *Poa* species flourished. One *Carex* species, *C. breviculmis*, cannot be found, but the other four species survived, although *C. fascicularis* struggles during drought conditions. It was primarily due to the success of the large tussock grasses that some small, delicate plants, such as Swamp Goodenia *Goodenia humilis*, Angled Lobelia *Lobelia alata* and the Sprawling Bluebell *Wahlenbergia gracilis*, did not survive The aquatic species coped well. Even during prolonged dry spells Common Nardoo *Marsilea drummondi* and River Buttercup *Ranunculus inundatis* continued to thrive.

Water Depth

We placed a depth marker in the water in August 1994, when the depth was 11 cm. By the end of November only small puddles remained and by 27 November 1994 the pond was completely dry (Fig. 3).

During the next few months the pond remained dry and baked hard with large cracks. Common Nardoo covered approximately 70% of the pond area (Fig. 4). It was not until 2 April 1995 that small puddles appeared and, a week later, we recorded a water depth of 2.5 cm. On the 29 April we noticed a new aquatic weed Common Starwort *Callitriche stagnalis* and a filamentous alga, *Spirogyra* sp. The *Spirogyra* flourished during the following months, but by the end of November, with a water depth of 19 cm, only a small amount remained around the edges and this soon disappeared.

The highest water depth of the study period was 30 cm on 6 August 1995. From then on water remained in the pond until the final day of the study, 2 February 1996, when it was dry again and almost completely covered with Common Nardoo, except in the shaded area in the south under the Pine Tree *Pinus radiata*.

Fig. 5 shows the variations in water depths throughout the period August 1994–February 1996 and the length of time when the pond was completely dry.

Fig. 3. Glenburn Pond, November 1994, completely dry.

Water Life

We collected both water and mud samples once a month from three locations in the pond; the north and south ends and the middle, and Dan McInnes, a FNCV member, agreed to analyse the samples for any waterlife. Table 1 shows the results of these investigations.

During the five months of the summer of 1994-5 when the pond was dry, we worried about the waterlife. We could have saved ourselves the concern, as no sooner did a small puddle develop than the water samples teemed with frog spawn, crustaceans, worms, insects, algae and rotifers.

Birds, mammals and frogs

Few birds and mammals were recorded. The only wetland birds we sighted on the site were the ubiquitous White Faced Heron *Ardea novaehollandiae* and numerous visits by a pair of Pacific Black Ducks *Anas superciliosa* and, on rare occasions, Chestnut Teals *Anas castanea* and Wood Ducks *Chenonetta jubata*, although other birds were recorded flying over the area.

At one stage two juvenile Common Ringtail Possums *Pseudocheirus peregrinus* appeared in the Pine Tree, but disappeared a few weeks later.

Fig. 4. Glenburn Pond, south to north, December 1994, almost covered by Common Nardoo.

A Black Rat *Rattus rattus* and a Water-rat *Hydromys chrysogaster* were found dead on the site and we occasionally saw small skinks and, once only, an unidentified lizard.

On 23 November 1995 two members of the Fauna Survey Group of the FNCV, Susan Myers and Stuart Dashper, conducted a night fauna survey, but no life was observed at the study site itself. Susan and Stuart were not surprised at this finding because of the lack of vegetation, hence cover, between the creek and the Glenburn Pond.

Murray Littlejohn assisted us with the identification of the first frog we found - the Southern Brown Tree Frog, *Litoria ewingi*. We later identified the Striped Marsh Frog *Limnodynastes peroni*, the Spotted Marsh Frog, *Limnodynastes tasmaniensis* and the Common Froglet *Ranidella signifera*.

During 1995 the Friends placed bat boxes on a tree in the study area, but no bats were recorded during the study period.

Conclusions

Constructing urban wetlands is both fun and hard work and it is possible to achieve an attractive, reasonably natural looking wetland in a short time.

If we took on another similar project we would carry out many of the tasks in the same way, but we would initially prepare a plan for the planting, giving careful consideration to the hardiness of the plants and the aesthetics of the final product, rather than aim for many diverse species. We would also landscape with logs, rocks and other natural elements as habitat for small fauna.

The most important outcomes of this project are that the Glenburn Pond area has been enhanced, the pond provides a real example of what can be achieved in an urban setting (Fig. 6) and the project created a focus for us to learn about many aspects of the natural world.

Acknowledgments

Our family members and members of Friends of Gardiners Creek Valley for their help throughout the study. And to members of the FNCV John Stewart, Dan McInnes, Tom May, Susan Myers and Stuart Dashper as well as Murray Littlejohn (University of Melbourne), for their expert help and advice.

Note: If you would like more information about

the project please contact Kathleen Ralston on 9509 4390 or Elaine Moir on 9885 7721. We have prepared a list of weeds that occurred on our site, showing their form, their mode of dispersal, when they flower and their potential risk,which may be helpful to others involved in revegetation of wetlands.

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Table 1. Water life collected in water and mud samples.

Protozoa	*Trichocerca tenuior*	**Arthropoda**	Diptera
Halteria	*Trichocerca rattus*	Arachnida	*Culex*
Rhizopoda	*Keratella* sp.	Hydracarina	*Chironomus*
Difflugia	*Limnias* sp.	Crustacea	Stratiomyidae
Ciliata	*Hexarthra* sp.	Ostracoda	**Algae**
Colpoda	*Wolga* sp.	Copepoda	*Anabaena* sp.
Opercularia	*Platyias* sp.	Calanoida	*Euglena acus*
Paramecium (slipper animalcule)	*Filinia* sp.	Cyclopoida	*Euglena clavata*
Vorticella	*Syncheata* sp.	Cladocera	*Euglena deses*
Diatoms	*Horaella* sp.	*Chydorus*	*Euglena oxyuris*
Achnanthes	*Anuraeopsis* sp.	*Simocephalus*	*Euglena tripteris*
Diatoma	*Brachionus* sp.	*Moina*	*Euglena* sp.
Gyrosigma	**Nematoda**	Insecta	*Gonium pectorale*
Navicula	Nematodes	Odonata	*Oscillatoria* sp. (fine)
Pleurosigma	**Platyhelminthes**	Collembola	*Pandorina*
Surirella	Turbellaria	Hemiptera	*Phacus triqueter*
Synedra	**Mollusca**	Corixidae	*Phacus* sp.
Cnidaria	Gastropoda	Notonectidae	*Spirogyra* sp.
Hydra sp.	**Annelida**	Coleoptera	*Trachelomonas* sp.
Rotifera	Oligochaeta	*Hydrobius*	*Volvox* sp.
Rotaria neptunia	*Chaetogasta*	*Dytiscus*	
		Hydrachara	

Appendix 1. List of weed species (# denotes those noted in J. Stewart's April 1994 survey).

Agrostis capillaris (Brown-top Bent-grass)
Allium triquetrum (Three-corner Garlic)
Anagallis arvensis (Scarlet Pimpernel)
Arctotheca calendula (Capeweed)
Aster subulatus (Aster-weed)#
Brassica fruticulosa (Twiggy Turnip)
Brassica tournefortii (Wild Turnip)#
Briza minor (Shivery Grass)
Bromus catharticus (Prairie Grass)#
Callitriche stagnalis (Common Starwort)
Cerastium glomeratum (Mouse-ear Chickweed)#
Chenopodiumn album (Fat Hen)#
Conyza albida (Tall/Pink Fleabane)#
Conyza bonariensis (Flaxleaf Fleabane)
Cynodon dactylon (Couch Grass)#
Cyperus eragrostis (Drain Flat-sedge)#
Cyperus tenellus (Tiny Flat-sedge)
Fraxinus rotundifolia (Desert Ash)
Galium aparine (Cleavers)
Geranium dissectum (Cutleaf Crane's Bill)
Grevillia robusta
Helminthotheca echioides (Ox-tongue)#
Hypochoeris radicata (Catsear or Flatweed)#
Juncus articulatus (Jointed Rush)
Lolium rigidum (Wimmera Rye Grass)
Malva parviflora (Small-flowered Mallow)#
Modiola caroliniana (Red-flowered Mallow)#
Onopordum acanthium (Scotch Thistle)
Paspalum dilatatum (Paspalum)#
Paspalum distichum (Water Couch)#
Pennisetum clandestinum (Kikuyu)
Pinus radiata (Monterey Pine)#
Plantago lanceolata (Ribwort)#
Plantago major (Large Plantain)
Polygonum aviculare (Prostrate Knotweed)#
Poa annua (Winter Grass)
Polygonum aviculare (Wireweed)#
Polypogon monspieliensis (Annual Beard Grass)
Ranunculus repens (Creeping Buttercup)
Ranunculus muricatus (Sharp Buttercup)
Raphanus raphanistrum (Wild Radish)
Romulea rosea (Onion Grass)
Rubus ulmifolius (Blackberry)
Rumex conglomeratus (Clustered Dock)
Rumex crispus (Curled Dock)#
Setaria graciis (Slender Pidgeon Grass)#
Sisymbrium irio (London Rocket)
Solanum nigrum (Black Nightshade)#
Soleirolia soleirolii (Baby's Tears)
Sonchus oleraceus (Common Sow Thistle)#
Taraxacum officinale (Dandelion)#
Trifolium dubium (Suckling Clover)
Trifolium repens (White Clover)
Trifolium subterraneum (Subterraneum Clover)#
Veronica persica (Creeping Speedwell)#
Vulpia bromoides (Squirrel-tail Fescue)

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Issue 3 (June 1997) was a special issue on
Mistletoes in the Australian Landscape.

Appendix 2. List of species planted (# denotes those noted in J. Stewart's April 1994 survey).

Acacia mearnsii (Black Wattle)#
Acaena novae-zelandiae (Bidgee Widgee)
Agrostis avenacea (Common Blown Grass)
Arthropodium milleflorum (Nodding Chocolate Lily)
Arthropodium strictum (Chocolate Lily)#
Banksia marginata (Silver Banksia)
Bossiaea prostrata (Creeping Bossiaea)
Brachyscome cardiocarpa (Swamp Daisy)
Brachyscome multifida (Cut leaf Daisy)
Bulbine bulbosa (Bulbine Lily)#
Bursaria spinosa (Sweet Bursaria)
Caesia calliantha (Blue Grass Lily)
Carex appressa (Tall Sedge or Tussock Sedge)
Carex breviculmus (Short Flower Sedge)
Carex fasicularis (Tassel Sedge)#
Carex inversa (Knob Sedge)
Carex tereticaulis (Common Sedge)
Clematis microphylla (Small leafed Clematis)
Correa reflexa (Common Correa)
Craspedia variabilis (Common Billy Button)#
Crassula helmsii (Swamp Stonecrop)
Danthonia caespitosa (Common Wallaby Grass)
Danthonia spp.
Dianella revoluta var. *revoluta* (Black Anther Flax-lily)
Dianella tasmanica (Flax Lily)#
Eleocharis acuta (Common Spikerush)
Eleocharis sphacelata (Tall Spikerush)
Epilobium billardierianum ssp. *billardierianum* (Robust Willow Herb)#
Epilobium billardierianum ssp. *cinereum*#
Epilobium hirtigerum (Hoary Willow Herb)#
Eucalyptus botryoides (Mahogany Gum)#
Eucalyptus camaldulensis (River Red Gum)#
Gahnia sieberiana (Red-fruited Saw-sedge)
Geranium potentilloides (Crane's Bill)
Geranium solanderi (Austral Crane's Bill)#
Goodenia humilis (Swamp Goodenia)
Indigofera australis (Austral Indigo)
Isolepis cernua (Grassy Club-rush)
Isolepis nodosa (Nobby Club-rush)
Juncus australis (Austral Rush)
Juncus bufonius (Toad Rush)
Juncus holoschoenus (Joint leaved Rush)
Juncus pallidus (Pale Rush)
Juncus procerus (Tall Rush)
Juncus sarophorus (Broom Rush)
Juncus spp.#
Kennedia prostrata (Running Postman)
Kunzea ericoides (Burgan)
Lepidosperma laterale var. *laterale* (Variable saw sedge)
Leptorhynchos tenuifolius (Wiry Buttons)
Linum marginale (Native/Wild Flax)
Lobelia alata (Angled Lobelia)
Lomandra filiformis (Wattle Mat-rush)#
Lomandra longifolia (Spiny-headed Mat-rush)
Lythrum hyssopifolia (Small/Lesser Loosestrife)
Marsilea drummondi (Common Nardoo)#
Melaleuca ericifolia (Swamp Paperbark)
Myriophyllum simulans (Water Milfoil)#
Persicaria decipiens (Slender Knotweed)#
Platylobium obtusangulum (Common Flat-pea)
Poa ensiformis (Purple-sheath Tussock Grass)
Poa labillardieri (Common Tussock Grass)#
Poa morrisii (Velvet Tussock Grass)
Poa sieberiana (Tussock Grass)
Prunella vulgaris (Self-heal)
Ranunculus inundatis (River Buttercup)#
Schoenoplectus validus (River Club Rush)
Schoenus apogon (Common Bog-rush)
Solanum aviculare (Kangaroo Apple)#
Stipa spp.
Themeda triandra (Kangaroo Grass)#
Triglochin procerum (Water Ribbons)#
Veronica gracilus ((Slender Speedwell)
Villarsia reniformis (Running Marsh Flower)
Viminaria juncea (Native Broom)
Viola hederacea (Ivy-leafed Violet)
Wahlenbergia gracilis (Australian/Sprawling Bluebell)

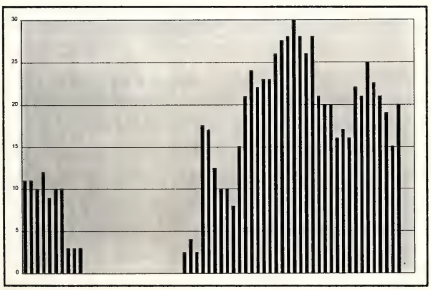

Fig. 5. Water depth (cm) taken, approximately every week, between August 1994 and February 1996.

Fig. 6. Glenburn Pond, south to north, November 1995.

Biology and Aquaculture of Silver Perch, *Bidyanus bidyanus* (Mitchell 1838) (Teraponidae): A Review

Golam Kibria[1], Dayanthi Nugegoda[1], Robert Fairclough[2] and Paul Lam[3]

Abstract
The Silver Perch *Bidyanus bidyanus* is the most important fish contributing to major endemic freshwater aquaculture production in Australia. The demand to culture the species is growing in nearby Asia. This is a review of its natural distribution, food and feeding habits, important biological characteristics, and of different aspects of Silver Perch aquaculture including breeding, nutrition, growth performance in freshwater and slightly saline waters. The review also includes data on Silver Perch production and the quality and quantity of wastes generated from aquaculture of Silver Perch.
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Introduction

Silver Perch *Bidyanus bidyanus* is an Australian endemic species with a high aquaculture potential (Allan and Rowland 1996). It is one of the species of the Murray-Darling River system that is much sought after by commercial and recreational fishers (Cadwallader 1979). The species was once abundant and widespread throughout the Murray-Darling River system but its distribution and abundance have been greatly reduced, and the fish is now uncommon in many areas (Rowland 1995a). Demand to cultivate the species is increasing both in Australia and in nearby Asia (Gooley and Rowland 1993) and, currently, *B. bidyanus* represent the main endemic freshwater aquaculture industry in Australia. There are some reports on *B. bidyanus* biology and aquaculture, however, this information is scattered in different journals, books and magazines. The present paper reviews and collates all the important information published on Silver Perch biology and aquaculture.

History, Natural Habitats and Status

Bidyanus bidyanus (Mitchell 1838) (Teraponidae) is endemic to most of the Murray-Darling river system (Merrick and Schmida 1984) except in the cool, high upper reaches of streams (Lake 1967a; Pollard *et al.* 1990; Merrick and Schmida 1984). It is a potamodromous species, i.e. migrates within the freshwater habitat (Guo *et al.* 1995). The species was commonly consumed by the Aborigines, and the scientific name was also derived from the Aboriginal name *bidyan* (Rowland 1995a) by the explorer Major Thomas Mitchell who named the fish after he caught it in the Namoi River in 1832 (Mitchell 1838).

The species was once abundant but its population has been greatly reduced due to competition for food from introduced cyprinids e.g. Common Carp *Cyprinus carpio*, predation by the English Perch *Perca fluviatilis*, and the construction of dams that prevented the upstream migration of *B. bidyanus* (Cadwallader and Backhouse 1983). It is now a 'Potentially Threatened' species (Jackson 1994) and may become 'Endangered' unless measures are taken to increase its population (Rowland 1994). Such measures might include aquaculture since *B. bidyanus* has a number of characteristics that make it a viable proposition for aquaculture.

Biological Characteristics of Silver Perch

This species can tolerate a wide range of temperature, from 2.0°–32°C (Cadwallader and Backhouse 1983), but the optimum growth temperature range is believed to be 23°–28°C (Rowland 1995b). Apart from the temperature, growth may also be affected by the ammonia levels (NH_3). Since fish can tolerate only a low level of ammonia (Table 1), higher ammonia levels in the culture system may stress and cause mortalities to fish (Boyd 1990; Hart and O'Sullivan 1993). Prolonged exposure of *B. bidyanus* at a concentration of over 0.1

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Table 1. Water quality variables recommended for intensive Silver Perch aquaculture (Rowland 1995c).

Variables	Recommended	Optimum for growth
Temperature (°C)	10-30	23-28
Dissolved oxygen (mg/l)	>4.5	
pH	7.0-9.5	
Total ammonia nitrogen (TAN) (mg/l)	<2.0	
NH_3 (mg/l) (unionised ammonia)	<0.1	

mg/l total ammonia caused a significant reduction in growth (Rowland 1995c; Rowland *et al.* 1995). The important water quality parameters for *B. bidyanus* are given in Table 1.

Males become mature in their second year (233 mm) while females mature in their third year (340 mm) (Cadwallader and Backhouse 1983; Merrick and Schmida 1984). However, adult fish may die after spawning (Lake 1967b; Cadwallader and Backhouse 1983). Spawning occurs in summer (November–January) when sexually mature fish migrate upstream to spawn in shallow, warm waters (Cadwallader 1977; Merrick 1980; Cadwallader and Backhouse 1983; Reynolds 1983). Flooding is thought to be required for natural spawning of *B. bidyanus* (Davis 1977). The fecundity is high and the number of eggs per female varies from 300,000 (Merrick 1980) to 500,000 eggs (Whitley 1960). Eggs are pelagic with diameter of 2–8mm (Lake 1967c). Hatching occurs after about 30 hours at temperatures of 22°–31°C (Cadwallader and Backhouse 1983). The larvae are benthic (Lake 1967b) and juveniles form large schools (Lake 1967a; Merrick 1980) often congregating below rapids, weirs (Merrick 1980) and fast flowing water with sand and gravel bottom (Llewellyn 1983; Merrick and Schmida 1984; Starling 1992). Adults can live in extremely turbid waters (Cadwallader 1977) and the species is tolerant of high salt concentrations (Ingram *et al.* 1996). Silver Perch is also a territorial and aggressive fish (Cadwallader and Backhouse 1983; Starling 1992). Within two years of hatching the average size could be 180 mm (Cadwallader and Backhouse 1983) and common sizes usually caught are 350–410 mm (0.75–2.5 kg) (Merrick and Schmida 1984). The pre-spawning activities of *B. bidyanus* have been described by Merrick and Schmida (1984).

Food and Feeding Habitats

The young fish (larvae) starts feeding from the sixth day after hatching, mainly on zooplankton including rotifers, copepod nauplii, small copepods and cladocerans (Cadwallader and Backhouse 1983; Rowland 1984; Thurstan and Rowland 1995). However, adult fish are omnivorous and, at times, feed extensively on zooplankton, particularly the larger ostracods and cladocerans. Other food includes shrimps (*Macrobrachium* spp., atyids), yabbies, chironomid larvae, aquatic insects, earthworms, molluscs, filamentous algae, and aquatic plants (Lake 1967a; Cadwallader and Backhouse 1983; Merrick and Schmida 1984; Rowland 1994). The natural zooplankton identified from earthen ponds under *B. bidyanus* culture comprised *Moina micrura*, *Daphnia carinata* (cladocerans), *Boeckella fluvialis* (copepod) and *Brachionus calyciflorus*, *Asplanchna sieboidi* (rotifers) (Culver and Geddes 1993).

Aquaculture of Silver Perch

Bidyanus bidyanus has been identified as the only wholly freshwater species in Australia with a tremendous potential for aquaculture (Allan and Rowland 1996). There are a number of characteristics that make *B. bidyanus* an ideal species for aquaculture: a rapid and uniform growth in crowded conditions (Barlow 1986; Pollard 1986) (the current stocking densities in earthen ponds is 10,000 fingerling/ha with aeration and 5000 fingerlings/ha without aeration; Walker 1993); its effective use of both plant proteins and meat meal (Allan and Rowland 1996); its low production cost, high fecundity and ready acceptance of low-protein diet (Barlow 1986; Rowland and Barlow 1991; Walker 1994a, 1994b); tolerance of high temperatures (Pollard 1986); omnivorous feeding habit (Rowland and Kearney 1992); and high demands for its culture in Australia and

Table 2. Comparison of native Silver Perch and native finfish production during 1994/95 (O'Sullivan and Kiley 1996). Key: NDA = No details available; NSW = New South Wales; NT=Northern Territory; TAS=Tasmania; SA=South Australia; QLD=Queensland; VIC=Victoria; WA=Western Australia

	farm (tonnes)	hatchery (000's)	value ($,000)
FINFISH			
Statewise Silver Perch production			
Silver Perch (NSW)	17.3	1,807.3	635.8
Silver Perch (Vic)	1	NDA	10
Silver Perch (Qld)	34.4	400.0	331.9
Silver Perch (SA)	-	-	-
Silver Perch (WA)	-	-	-
Silver Perch (Tas)	-	-	-
Silver Perch (NT)	-	-	-
Silver Perch and other native finfish production during 1994/95			
Silver Perch (all states)	52.7	2,207.3	977.7
Golden perch (all states)	0.5	2,498.9	397.0
Murray cod (all states)	<0.1	196.7	101.3
Trout cod (all states)	0	32.1	3.4
Australian bass (all states)	<0.1	274.3	95.6
Catfish (all states)	0	44.5	42.6
Macquarie perch (all states)	0	53.0	5.4
Mary River cod (all states)	0	4.7	7.0

Table 3. Native fish production and contribution from Silver Perch during 1988 to 1995.

Year	Native fish farm production (t)	Silver Perch contribution (t)	Source
1988-89	10	-	Treadwell *et al.* (1992)
1991-92	43.9	26.6	O'Sullivan (1995)
1994-95	53.2	52.7	O'Sullivan & Kiley (1996)

Asia (Gooley and Rowland 1993). *B. bidyanus* farming is a major endemic fish culture industry in this country as demonstrated by its production figures (Tables 2 and 3) and has the potential to achieve an annual production of 10 t/ha (Rowland 1995b; Walker 1994a). Major *B. bidyanus* farms are small (1–3 ponds) although there are some medium sized farms (4–8 ponds) and a few large farms (6–17 hectares) (Walker and Caney 1996).

The aquaculture of *B. bidyanus* is dominant in Queensland (Qld) and in New South Wales (NSW). These two states contributed 98% of *B. bidyanus* production in 1994/1995 (Table 2). In fact, the increase in freshwater fish production in Australia is mainly due to the interest and investment in growing *B. bidyanus* (Kibria *et al.* 1996) (see also Table 3).

To achieve the best result for raising *B. bidyanus*, research has been undertaken by a number of different authors on the breeding, nutrition, growth performance in ponds, tanks, and saline waters. The potential effects of pollution from rearing of Silver Perch has also been examined. Findings of the above research are summarised below:

Research in the Artificial Breeding of Silver Perch

Techniques on the artificial propagation of *B. bidyanus*, along with other endemic species have been developed at the Inland Fisheries Research Station, Narrandera, Eastern Freshwater Fish Research Hatchery, Grafton, both in New South Wales, and at Snobs Creek Freshwater Fisheries Research Station and Hatchery in Victoria (Rowland *et al.* 1983; Rowland 1984). The techniques involved the induction of breeding of endemic fish by using an artificial hormone (**H**uman **C**horionic **G**onadotrophin, HCG) and a preparation of the pituitary gland from Common Carp (**C**arp **P**ituitary **G**land, CPG). The optimum dose of HCG that induced a high hatching rate of eggs in *B. bidyanus* was 200 IU/kg HCG (Rowland 1984). About three million *B. bidyanus* fry are produced annually by induced breeding for stocking farm dams and other natural waters used for recreational fishing (Rowland *et al.* 1995).

Research on Silver Perch Nutrition

Research has been undertaken on the nutrition and production of *B. bidyanus* by a number of authors, including Allan and Rowland (1991), Rowland and Barlow (1991), Allan and Rowland (1992), Allan and Rowland (1994). Out of three experimental diets tested (21%, 36% and 49% protein), Allan and Rowland (1991) obtained the fastest growth rate of *B. bidyanus* using a diet containing 36% protein. Based on this trial, Allan and Rowland (1992) developed the first reference diet for *B. bidyanus* which contained 35.6% protein, 5.5% fat, and 1.1% fatty acids. The total methionine and lysine composition (the limiting amino acids in feed) of the reference diet was 7.4 and 22.6 g/kg respectively. *B. bidyanus* fed a diet containing 35% protein showed better **F**ood **C**onversion **R**atio (FCR) than when fed a diet containing other levels of protein (Allan and Rowland 1991) whereas Kibria *et al.* (1997a.) found comparatively higher growth and FCR of *B. bidyanus* using a diet containing 45% protein (Table 4).

Research has also been undertaken on the use of Australian oilseeds (Soybean, Canola, Cottonseed, and Peanut) and grain legumes (Lupins, Chick Pea, Field Pea and Cow Pea) as ingredients of *B. bidyanus* diets and results are encouraging, since apparent digestibility coefficients (ADC's) of vegetable protein is similar to, or higher than, that obtained with fish meal (Allan and Rowland 1994). The research found that *B. bidyanus* is good at digesting vegetable protein, and the best growth of the fish was obtained from peanut meal. The next best was soybean meal followed by lupin and canola meal. However, research also found that growth of *B. bidyanus* decreased, and the FCR value deteriorated with the increase of plant protein content. Very poor FCRs resulted when *B. bidyanus* were fed with a high fibre diet (O'Sullivan 1994). Studies were also carried out on the effects of varying protein and energy concentrations, the result of which show that growth of *B. bidyanus* increased with increasing protein and energy level in diets (Allan *et al.* 1994). The fat deposition in *B. bidyanus* was directly related to the fat content of diets (Anderson and Arthington 1989; Hunter and Roberts 1994). Further experimental trials confirmed that *B. bidyanus* require in their diet fatty acids of both the linolenic (18:3n–3) and linoleic (18:2n–6) series (Anderson and Arthington 1989). A synopsis of nutritional research on *B. bidyanus* is given in Allan and Rowland (1996).

Growth and Production of Silver Perch

Growth of *B. bidyanus* is also affected by the rearing temperature. During winter months (May–September), the growth rate is significantly slower than in the warmer months (October–March) (Table 5). *B. bidyanus* eat aggressively at a temperature above 20°C and are less aggressive in winters. Although *B. bidyanus* grow better in temperatures above 20°C, prolonged exposure at 30°C and above adversely affects the appetite, food conversion and growth of the species (Rowland 1995c).

The *B. bidyanus* fry grew faster at a stocking density of 25,000/ha than at 80,000/ha in earthen ponds (Rowland *et al.*

Table 4. Effect of dietary protein levels, and rearing temperature on food conversion ratio (FCR) of Silver Perch.

Protein content (%)	Feeding rate % BW[1]/day	Water temperature	FCR system	Culture	Source
20.7%	satiation	18.3–22.8°C	3.0+0.2	Tank	Allan and Rowland (1991)
35.7%	satiation	18.3–22.8°C	1.7+0.1	Tank	Allan and Rowland (1991)
49%	satiation	18.3–22.8°C	2.4+0.3	Tank	Allan and Rowland (1991)
36%	3%	18.0–20.0°C	3.20	Aquaria	Kibria *et al.* (1997a)
45%	3%	18.0–20.0°C	2.24	Aquaria	Kibria *et al.* (1997a)
53%	3%	18.0–20.0°C	2.97	Aquaria	Kibria *et al.* (1997a)
35%	5%	22.0–26.6°C	1.1-1.2	Pond	Rowland *et al.* (1994)
35%	4% & 3%	13.2–28.4°C	1.8-1.9	Pond	Rowland *et al.* (1995)
35%	3%	–	1.0-1.3	–	Allan and Rowland (1992)
35%	3%	12.5–30.3°C	2.3	Pond	Rowland (1995d)
50%	3%	22.0–31.3°C	0.7	Pond	*Rowland (1994)

[1]BW = body weight; * = Rowland commented that FCR was better apparently due to eating natural pond food as well.

Table 5. Growth of Silver Perch reared in ponds at different seasons

Months	Seasons	Temperature	Growth (g/d)	Source
May-September	Winter	11.1-20°C	0.5	Rowland (1995b)
October-March	Summer	>20°C	2.3 (low density)	Rowland (1995b)
October-March	Summer	>20°C	2.1 (high density)	Rowland (1995b)

1994). When *B. bidyanus* were reared at a higher density (43,000 fish/ha), the annual production figure was calculated to be 10.2 tonnes/ha (Rowland 1995d; Rowland *et al.* 1995). However, at higher density culture, particularly during summer, the water quality may deteriorate resulting in an increase of disease susceptibility (Rowland 1995d).

Performance of Silver Perch in Tanks/Cages

McKinnon *et al.* (1996) obtained comparatively better growth and survival of *B. bidyanus* in floating cages fixed in irrigation channels in integrated aquaculture-irrigation systems, while poor growth and survival resulted from cages fixed in tanks supplied with groundwater. The growth and FCR of *B. bidyanus* was significantly lower in tanks than in earthen ponds (Rowland 1995b). Similarly, growth of *B. bidyanus* was found to be slower in aquaria compared to commercial ponds (Kibria *et al.* 1997a).

Performance of Silver Perch in Saline Waters

Bidyanus bidyanus can tolerate salinity up to 15 parts per thousand (salinity) (Guo *et al.* 1995) and larvae hatched at six salinity showed a better survival rate than those hatched in freshwater (Guo *et al.* 1993). Ingram *et al.*(1996) reported a good survival and growth of *B. bidyanus* when reared in cages at a salinity of 8.0–15.3 salinity, whereas poor growth and survival resulted at higher salinities of 9.5–24.6 salinity. The growth and survival obtained at 8.0–15.3 salinity were better than those of similar sized fish reared in freshwater cages (Ingram *et al.* 1996). Recently, we reared *B. bidyanus* fingerlings at different salinity levels (0 salinity, 4 salinity, 8 salinity and 12 salinity) in order to evaluate growth and nutrient retention efficiency. *B. bidyanus* grew faster and had a better FCR and nutrient retention at 4 salinity than at other salinities (Kibria *et al. unpubl. data*).

Pollution Potential from Aquaculture of Silver Perch

Kibria *et al.* (1997b) reared *B. bidyanus* fingerlings at 20°C, 25°C and 30°C to investigate the solid waste production and nutrient loading to the environment. *Bidyanus bidyanus* grown at 25°C produced significantly less solid waste and nutrient load ($P<0.05$) compared with other temperatures in the order of 25°C< 30°C<20°C. In another experiment we found that the diet which resulted in *B. bidyanus* having comparatively higher weight gain, specific growth rate (SGR) and food conversion ratio (FCR) produced less suspended and dissolved solid waste to the environment (Kibria *et al.* 1997a). *Bidyanus bidyanus* grown at 25°C produced less nitrogen and phosphorus load to the environment and this could be due to the better growth, good FCR and lower faecal and metabolic loss obtained at that temperature (Kibria *et al.* 1997b; Kibria *et al.* 1997c).

Conclusion

The endemic fish *B. bidyanus* has great potential as a freshwater aquaculture species in Australia. The biology and nutrition of the species are well established. Recent study shows that growing *B. bidyanus* at their optimum temperature may enhance nutrient retention and a reduction in the discharge of nutrient to the environment. For a sustainable aquaculture programme, development of low polluting *B. bidyanus* diet and experiments on polyculturing of *B. bidyanus* would be important areas for future research. Moreover, further experiments on rearing of *B. bidyanus* in slightly saline waters may provide pertinent data of its suitability of culturing in brackish water zones.

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Fungi of Southern Australia

by Neale L. Bougher and Katrina Syme

Publisher: *University of Western Australia Press. ISBN 1 875560 80 7*
391 pages, 125 colour plates, numerous line drawings. RRP $75.00.

This is an outstanding work which sets a new benchmark for field guides and handbooks to the larger fungi of Australia. Along with a very comprehensive introductory section, the book brings together magnificent colour paintings by Katrina Syme, with detailed descriptions, based on extensive research by Neale Bougher. Some 125 species are illustrated, mostly agarics (mushrooms and toadstools), boletes and false-truffles, but also a small sample of puffballs, jelly fungi, coral fungi, bracket fungi, and ascomycetes. The species included are a mix of the common, the unusual and the rare, and the agarics depicted are as good a selection of the major genera as is possible when attempting to sample from the numerous genera. About a quarter of the species have not previously been illustrated in colour. Among these are more than two dozen newly described in the last few decades as a result of taxonomic revisions by Neale Bougher and others (e.g. *Amanita flaviphylla* and *Rozites symeae*), as well as some common but previously overlooked species such as *Inocybe australiensis*.

Alongside each illustration, the text

includes comprehensive descriptions of the fruit body and of the microscopic features, notes on the distinctive characters, and comments on edibility, habitat and comparisons to related species. Drawings of spores and other microscopic characters are provided for all illustrated species. These drawings are of a uniformly high standard, clearly based on many hours of careful study, as are the descriptions of macroscopic characters. The first hand observation that has gone into preparing the text and illustrations distinguishes *Fungi of Southern Australia* from some other field guides to Australian fungi, where the text is cobbled together from secondary sources. The citing of representative collections (lodged at the Perth Herbarium) for all species also sets this book apart from most other field guides. Availability of such collections will allow future checking of identifications, as classifications alter and new species are described. This will be especially valuable for the species which are provided with provisional names, or are indicated as having affinities to (but differing in some way from) known species.

The names used for the species are as up-to-date as is possible when dealing with the, as yet, incompletely known mycoflora, and it is evident that wherever possible experts in particular groups have been consulted in establishing the correct names. Where familiar names are not used, there is usually some explanation as to the change, as for the use of *Xerula australis* instead of *Oudemansiella radicata*, and the choice of *Tremella aurantia* for the *Tremella* often called *T. mesenterica*.

One interesting group which is well-represented are the false-truffles: gasteroid relatives of various gilled and other fungi. False-truffles such as *Descomyces, Austrogautieria, Hydnangium, Zelleromyces, Macowanites* and *Protubera* rarely appear in field guides. Despite their hidden habitat (not so much buried, as found just below the litter layer), they deserve to be better known because of their importance as food for mammals (such as bettongs and potoroos), and their interesting evolutionary relationships - discussed at the end of the introductory text.

The authors are both residents of Western Australia, and all the illustrations are based on collections from that state. It seems from the background provided on geology, climate and vegetation of south-western Australia, that the book was perhaps initially intended to cover the fungi of this region. The title 'Fungi of Southern Australia', is nevertheless certainly not misleading. All but a very few of the illustrated species *(Torrendia,* and a couple of species of *Amanita)* also occur in eastern Australia. This high level of overlap between the mycoflora of eastern and western Australia is an interesting contrast to the distinctiveness of the flowering plants of the south-west, but does mean that naturalists throughout southern Australia can make use of field guides to fungi prepared for localised areas.

The watercolours deserve special praise. In fungi, subtleties of colour and surface texture are important characters, and the hues in the coloured illustrations and the detail of surface fibrils and the like are mostly spot on. The gross form of the fruit bodies is also accurate, allowing for the necessary slight distortions needed to show different parts, such as cap, gills and stipe, not all clearly visible from a single point of view. This subtle alteration of perspective is rarely noticeable, except as an apparent elongation of the stipe of some species (perhaps because the fungi must be viewed from below to show the gills). Cross sections showing important identifying characters such as gill and flesh colour and gill attachment are provided where necessary, but do not detract from the artistry of the watercolours. In the gilled fungi the various ranks of gills and the gill spacing are faithfully shown, but for pore fungi the detail of the fertile surfaces is at times more impressionistic - perhaps an insert (as with the cross section of *Fistulina hepatica*) could have been used to show a magnified portion of the pore surface. The gleba of some of the false-truffles could also benefit from more detail. In only a few cases the illustrations are a little sketchy, with some detail missing, as for *Omphalina chromacea*, where the typical striae of the cap are obscure. Nevertheless, the best, such as *Coprinus comatus*, are superb. The general trueness of colour and form, and the way that the fungi are

presented against their natural substrate, whether litter or wood or soil, sets a standard for watercolours of Australian fungi.

I do not agree with the comments by Roger Hilton in the Foreword that watercolours eclipse photography as a method for scientific illustration of fungi. The two methods are complimentary and consulting a number of illustrations is generally found to assist when identifying fungi. In terms of the quality of the colour illustrations, *Fungi of Southern Australia* certainly stands alongside the best of the available field guides utilising photography (such as Fuhrer's *Field Companion to Australian Fungi*). Where it does eclipse other guides is in the depth of the text.

The chapters on 'Finding, collecting and processing fungi' and on 'Describing fungi' stand alone as an excellent manual on these topics. There is a desperate need for well prepared herbarium specimens of Australian fungi to be lodged in herbaria, and I will certainly be recommending that collectors peruse the relevant chapters, for the wealth of detail on how to find, collect, describe and dry fungi. There are also some very useful line illustrations showing various characters such as gill attachment, gill margins, stipe shape and so on.

A key to genera and species is not provided, but there is a chapter on the 'Main groups of fungi' which outlines in some detail the characters of the major groups, and for the agarics, the families occurring in the region (nearly all of which are represented among the illustrated species). The value of the work in terms of identification is that when one of the included species is observed, there will be little doubt of its identity, due to the detail of the descriptions and the accuracy of the illustrations.

Topics such as edibility, dyes, fungal nutrition and ecology and various other aspects are comprehensively covered in the introductory chapters. There is an extensive list of references and a very comprehensive glossary, with frequent cross-references to the illustrations. The book is sturdily bound and extremely well produced - in all the text I could find only a few minor errors (such as an incorrect cross reference on p. 85 for the illustration of *Bolbitius*). A few minor quibbles are that in the panel under the species name the order is given, but the family would also be useful (rather than under the illustration), and if there is any system to the colour used in this panel I could not work it out. Authors and publication details of scientific names could have been relegated to the list of representative collections, and the authors abbreviated.

One could also wish that more species had been included, but the sheer number of species of fungi means that this, as with all other available field guides to Australian fungi, is selective. The authors state that about 500 species of macrofungi are known from WA, but also mention that at just one site (Two Peoples Bay) more than 400 species have been collected which appear to be undescribed. In Victoria, I estimate that the known species of macrofungi, although uncatalogued, already exceed the vascular plant flora in number. How to cope with the magnitude of fungal biodiversity in relation to aspects such as ecological surveys, and the establishment of distribution and conservation status is one of the challenges that needs urgently to be addressed. *Fungi of Southern Australia* will stimulate and facilitate the large amount of work that remains.

The endpapers, of eucalypt leaf litter on the forest floor, stamp this as a distinctively Australian work, which takes the study of our macrofungi to the level long available for Northern Hemisphere mycofloras. Neale Bougher and Katrina Syme have produced a splendid book which is far and away the best field guide to Australian larger fungi. The balance between the accessibility of the watercolours and the comprehensiveness and scientific rigour of the text will satisfy the naturalist who wishes to identify fungi encountered on a bushwalk, but also provides a wealth of information for those who wish to extend their knowledge of this fascinating group.

Tom May

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A Conservation Overview of Non-marine Lichens, Bryophytes, Algae and Fungi

by George Scott, Timothy Entwisle, Tom May and Nell Stevens.

Publisher: *Environment Australia, Biodiversity Group. RRP $15.00.*
Available from The Botanical Bookshop, PO box 351, Jamison, ACT 2614.

Most people tend to overlook the small and cryptic elements in their environment and I suspect conservation biologists on the whole are guilty of this too. But for people interested in the conservation of all aspects of the Australian biota, then this book will be essential reading to understand the status of cryptogamic organisms and the many essential roles that they play. Indeed, I go so far as to say that this publication should be required reading in tertiary courses dealing with conservation biology. The paradox of these groups is that, although they are often small, they play major roles in ecosystem functioning. This keystone role is only becoming recognised as more assessments of biodiversity are undertaken. Such assessments are also highlighting the crucial lack of knowledge in the area - a fact that is pointed out several times throughout this book. Also highlighted is the lack of support for teaching mycology in research institutes. Is it any wonder then, that most new species of fungi in Australia are described by overseas taxonomists?

This publication is not just a reference source for recent information, but an important guide for conservation priorities. The chapters were initially penned independently; which could have been a recipe for disaster, but they slot together very well.

The conservation of biological diversity is very much at the forefront of our thinking these days and it has changed the way many of us do research. In the last decade we have seen the debate unfold about the best approaches to use to assay for biodiversity. Should we rely on indicator groups (Operational Taxonomic Units) to estimate biological richness of a particular ecosystem or should we in double-quick-time painstakingly collect specimens from all trophic levels and then determine overall diversity levels.

As the biology of conservation science develops, the realisation that the appropriate legislation needs to be understood and implemented is increasingly being acknowledged. Scott's introductory chapter brings together legislative information for cryptogams in Australia, although the material presented in this chapter is also very relevant to the vascular Australian Flora (I use this chapter in undergraduate teaching at UNE).

The book is set out in six chapters with an excellent *Introduction,* and then a chapter each on *Lichens, Bryophytes, Algae* and *Fungi,* and then a *Conclusion.* There is also a very conveniently located set of recommendations at the beginning of the book regarding the need for filling gaps in our knowledge and the steps that should be undertaken to meet the needs of conservation. Each chapter is well set out with details on the current knowledge as well as recommendations for future research priorities and conservation needs. There are also excellent bibliographies provided for each group. I was transferred to Lilliputian worlds in Tom May's chapter where mention was made of fungi on insects. The mind is boggled by the gargantuan levels of biodiversity in these Kingdoms.

The four appendices each contain very worthwhile information. *Appendix A* details a register of taxonomists (both national and relevant international experts) and, very importantly, a list of major holding venues for specimens in Australia. *Appendix B* has a list of threatened species (excluding fungi) and their critical habitats. For those of us using the familiar ROTAB coding, the authors basically follow this system, but there are some additional categories such as P '*Potentially Vulnerable*'. *Appendix C* has a collection of species that are of particular interest from a 'visual or other perspective' which should be included in education materials. However, there are many species listed in this section that should never be harvested from the wild and thus, this section should have carried a covering statement about the problems with over-collecting. Elsewhere in the book, the need for these restrictions is mentioned. *Appendix D* provides a useful glossary for us non-cryptogamic experts. For example, do you know what fruticose means in relation to non-fruiting cryptogamic lichens, and although you have probably heard about rhizoids, what about rhizines? It is all here in this very useful book.

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Sub-alpine Flora of the Baw Baw Plateau, Victoria

by Kathie and Peter Strickland

Publisher: *Kareelah, P.O. Box 31, Balnarring, Victoria 3926*
RRP $19.95. Also available from publisher for $20.00 including postage.

I really like this book and I'm sure that future summer visitors to the Baw Baw plateau will feel undressed if they don't carry a copy in their pack. It sets a high standard of species description and these descriptions are accompanied by some of the best botanical drawings I have seen in a book which is essentially a field guide. Congratulations to author and illustrator.

The book starts with a delightful little poem by Alan McMahon capturing the essence of the Victorian high country at the onset of autumn. Oh for *a thin wind whispering 'snow'* in this hot, Melbourne summer! A brief introduction to the geology, soils, topography and climate of the Baw Baw plateau is followed by descriptions of the four main vegetation types found on the plateau and their historical development. This general chapter ends with an historical summary of human activity in this outlier of the Victorian alps.

Then follows the main component of the book – a sequence of species descriptions and illustrations. The species have been grouped into 'Ferns and allied plants', 'Monocotyledons' and 'Dicotyledons' and then in alphabetical order of families. An index of common and scientific names is provided along with a glossary of technical terms. Species descriptions include leaf, flower and fruit details, as well as habit and habitat descriptions. Included are notes on the derivation of the plant name and the months of flowering and also the more general geographic distribution of the species. The 'Bibliography' lists important publications which generally delve more deeply into the subject of the Baw Baw flora.

I am strongly recommending the purchase of this well presented book, in particular because of the superb illustrations which will significantly aid identification. But, in fairness, I must introduce a note of caution to the enthusiastic field naturalist. Understandably, there is no key to the identification of the 125 plants described, so identification to the uninitiated naturalist will depend on matching the species you wish to identify with the descriptions and illustration in the book. Much time will be spent thumbing through the pages to get the correct match. This leads onto another difficulty since the book does not deal comprehensively with the entire flora of the plateau. If your plant of interest does not match correctly the description of the illustration, you most likely will be left with an unresolved identification, you may have to conclude that your plant is either a variant of a plant described, or something else which is not included in the book.

There are some minor problems of layout which could be corrected in any reprint. There are very good and clear drawings of the more complex flowers like orchids, grasses, daisies and peas. These would be more helpful if they appeared just ahead of the respective families. Choosing *Prasophyllum* as the representative of the orchid family is a bit unwise since this is a genus in which the labellum is located, as illustrated, on the top of the flower, whereas nearly all other orchids twist their flower stems so that the labellum is situated at the bottom of the flower. This confusion has probably lead to the incorrect labelling of the labellum in the illustration of *P. tadgellianum* on p. 47.

Changes of the scientific names of plants are the bane of many amateur field naturalists, but the authors need to be particularly careful to be consistent in the use of plant names. For instance, the Veined Sun-orchid – *Thelymitra cyanea* – is given the old name *T. venosa* on p. 3.

Despite the above concerns, I highly recommend this flora of the Baw Baw plateau as a wonderful contribution to an accessible understanding of the flora of Victoria.

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The Biology of Australian Weeds Volume 2

Edited by F.D. Panetta, R.H. Groves and R.C.H. Shepherd

Publishers: *R.G. and F.J. Richardson, PO Box 42, Meredith 3333.*
328 pages, printed on quality paper and is section sewn for strength.
Cost $59.50 plus $10 postage and handling.

The publication of *The Biology of Australian Weeds Volume 1* at the end of 1995 reviewed sixteen of Australia's worst weeds. Seventeen more of these weeds are now reviewed in the newly published *Volume 2*. These plants are responsible for significant land degradation and threaten farms, waterways and park land. They contribute significantly to Australia's weed costs of over $3 billion per year.

The Biology of Australian Weeds Volume 2 is another essential text for research staff, students, consultants, naturalists and others interested in weeds and the environment. The books are based on a series of papers by some of Australia's foremost weeds scientists, that were first published in the *Journal of the Australian Institute of Agricultural Science* and more recently in *Plant Protection Quarterly.* The papers, published over a period of 17 years, have been brought up-to-date by either the original authors or by other highly qualified researchers.

The detailed text has been edited by three of Australia's leading weed scientists: Dane Panetta at Alan Fletcher Research Station in Sherwood, Queensland; Richard Groves at CSIRO Division of Plant Industry in Canberra; Ros Shepherd, an entomologist originally from the Keith Turnbull Research Institute, Frankston, and now pursuing a career consulting on weed related topics.

Each weed is reviewed in considerable detail and information on its name, description, history, distribution, habitat preferences, growth and development, reproductive processes and hybridisation, population dynamics, importance in Australia, legislative restrictions and methods of management are examined in detail. The reviews are complemented with line drawings, maps, graphs and photographs.

The weeds described in this book are problems over a wide variety of areas in Australia. Cabomba *Cabomba caroliniana* and Common Reed *Pragmites australis* are weeds of aquatic areas. Parthenium Weed *Parthenium hysterophorus*, Rubber Vine *Cryptostegia grandiflora*, Lantana *Lantana camara* and Prickly Acacia *Acacia nilotica* are weeds of tropical pastures and natural ecosystems. Sifton Bush *Cassinia arcuata*, Doublegee *Emex australis*, Catsear *Hypochoeris radicata*, European Blackberry *Rubus fruticosus*, Fireweed *Senecio madagascariensis*, Gorse/Furze *Ulex europaeus*, Squirrel-tail Fescue *Vulpia bromoides* and Rat's-tail Fescue *Vulpia myuros* are weeds of temperate pastures. Doublegee *Emex australis*, Soursob *Oxalis pes-caprae*, Wild Radish *Raphanus raphanistrum* and the *Vulpia* spp. are weeds in cropping areas while Boneseed/ Bitou Bush *Chrysanthemoides monilifera*, Broom *Cystisus scoparius* and European Blackberry *Rubus fruticosus* are problem weeds in temperate bushland areas.

Other recent publications:

Crop Weeds
by J.L. Wilding, A.G. Barnett and R.L. Amor.
154 pages, $65.00 plus $10 postage.
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by M.R. Moerkerk and A.G. Barnett
124 pages, $55.00 plus $10 postage.

Crop Weeds and its newly published companion volume *More Crop Weeds* are essential manuals for farmers, agricultural research and extension agencies, universities and agricultural colleges, and companies offering services to farmers.

All three books are available from the Publishers *R.G. and F.J. Richardson, PO Box 42, Meredith, Victoria 3333.*

From our Naturalist in the Country

An Echidna visits the Farm

The Short-beaked Echidna or Spiny Anteater *Tachyglossus aculeatus* is one of the few native animals still relatively common in our farming districts. Many, alas, are killed on the roads and for years we kept a spring balance and a nappy in the car to weigh any, living or dead Echidnas that we found on the bitumen. The live ones were then escorted off the road. The heaviest we came across weighed eleven pounds (4.95 kg) and had been freshly killed. Almost always only the snout or bill was crushed. Possibly the animals are aware of the approaching car and are on the alert and listening intently instead of tucking the head underneath into safety. In the earlier days we knew them as 'porcupines' while those odd creatures that sat up in trees were 'monkey bears'.

However, this is the story of a wild Anteater that came to live around our farmhouse for a season and gave us some amusement and much pleasure.

He came marching down our drive one morning in late summer, a very juvenile ant-eater, and we were immediately enchanted. He weighed exactly one pound (450 g). In all my bush wanderings I had never seen one so young or as small as this. Now I know that in discussing the fauna it is proper to refer to an animal as IT. We hadn't a clue as to the sex of our visitor, but felt that such a determine d creature with such a strong personality could only be thought and spoken of as HE. Picked up and brought inside he showed great composure and accepted a saucer of milk with alacrity. The name of the species *Tachyglossus* means swift tongue, a very apt name indeed. The long, red tongue, like a thread of darning wool, is surprisingly swift and soon licked the saucer clean. Thereafter he was called by his proper name, shortened to Tachy.

We had no desire to imprison Tachy and soon returned him to the garden. Close by was the site of the original homestead, the area marked by much buried wood and heaps of broken bricks, all teeming with small black ants. Tachy soon discovered this and could generally be found bulldozing his way through eh debris and mopping up the masses of ants and their eggs. Anteaters have immensely strong pushing power and muscle control. It was an education to sit quietly beside Tachy while he worked so intently. His sense of hearing was acute but we concluded that his eyesight was poor. I have approached an adult echidna in the bush, and by standing perfectly still have had it come up and investigate my boots! Sense of smell must be keen, for Tachy could locate an ants nest under a brick half buried in soil.

Should I or my husband pass Tachy on our way in to lunch we would pick him up and set him on the kitchen floor with his milk ration, or better still, a bantam's egg with a convenient porthole opened in the side. He relished an egg and the swift tongue soon cleaned it of its contents. A question arises here. Would ant-eaters attempt to suck the eggs of ground-nesting birds, or would the unbroken shells foil them?? Weighed after his lunch, Tachy would turn the scale at one pound five ounces (591 g).

As we sat at our lunch Tachy would wander round testing the legs of the table and the diners for ants. When the damp bill came snuffling around my feet I would lift him onto my lap where, comfortably full, he would snuggle down for a few minutes. Soon his restless nature caused him to drop again to the floor. He had a penchant for climbing up between the fridge and the wall, suddenly appearing on the shiny top. One or other of us would leap to catch him before he toppled off. Set outside he would promptly return to the place from which he had been so rudely interrupted before lunch.

Echidnas are neither crepuscular nor nocturnal. They are most active in the middle of the day. Often by five o'clock Tachy would be in bed. We noticed that, as we passed the loose, dry earth in the lee of the paling fence, the ground would suddenly flinch. We knew that Tachy had retired and was disturbed by the vibration of our passing footfalls.

If naturalist friends were expected, and it was desired to have Tachy handy for inspection, we would attempt to confine.him. In the back yard there was a bottomless half tank that sometimes housed chickens. Dropped into this with a selection of ant-infested logs from the woodheap he would soon become bored, and begin to case the joint. He found a precarious foothold in the row of rivets that joined the sheets of iron together. Cleverly he would climb by way of the rivets until he could hook his strong neck over the rim and fall to freedom. Edith Coleman, writing in *The Victorian Naturalist* in the 1930s, told about the echidnas that she kept for study purposes. She remarked upon their astonishing climbing ability. They were able to ascend the wire netting right to the roof, from where they ungracefully fell back into the pen again. Edith also considered that they were neither crepuscular nor nocturnal foragers, but were most active in the early afternoon.

Nature has not designed these independent freedom-loving creatures for pets and I would be sorry to see any of them kept in captivity. We can enjoy their company in the short while that their lives touch on ours and wish them well when they go. As the autumn wore on, we noticed Tachy ranging further afield until finally we lost track of him. Such a young animal would be very vulnerable to foxes, because, if they managed to tip him over, it would be quite easy to tear into the soft under-belly.

Ellen Lyndon
7 Steele Street, Leongatha, Victoria 3953.

Books Available from FNCV

The Club has, over the years, published a number of books on natural history topics which can be purchased from the Book Sales Officer. It is currently distributing five:

A Field Companion to Australian Fungi (B. Fuhrer)..........................$19.95
A reprint of the earlier book with additional photographs and incorporating name changes.

Down Under at the Prom. (M. O'Toole and M. Turner).......................$16.95
A guide to the marine sites and dives at Wilson's Promontory (with maps and numerous colour illustrations).

Roadside Geology, Melbourne to Ballarat (ed. Noel Schleiger)..........$18.00
A wealth of geological information on the area between Melbourne and Ballarat (with sketches and maps).

What Fossil Plant is That? (J.G. Douglas) $12.50
A guide to the ancient flora of Victoria, with notes on localities and fossil collecting.

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144 magnificent illustrations of the spectacular flora of this region.

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Book Sales Officer 9850 2617 (H)

John Roslyn (Ros.) Garnet, AM
1906–1998

Members of the Field Naturalists Club of Victoria and indeed all Victorian conservationists have been saddened by the recent passing of Ros Garnet, one of our great members and supporters, who died on 7 February, at the age of 91. At the time of his death the FNCV, was holding one of its Centennial Field Excursions to Mount Buffalo National Park, and I was pleased to be able to send a short tribute to be read at his funeral service, which included the following extract:-

> 'From the snow plains of Mount Buffalo National Park, we pay tribute to J. Ros Garnet - a great Australian who dedicated his life to the cause of nature conservation, natural history and the concept of national parks. As we look around this land of the Snow Gum, we see the fruits of his endeavours, and it is hard to find words which adequately convey an appreciation of his foresight, his total commitment and uncompromising support for National Parks in Victoria and elsewhere'.

Without doubt Garnet's greatest achievements have been in the field of natural history and conservation. He was always passionately interested in the natural world. His home study was a treasure trove of books, journals, drawings and collections, all of which he treasured and understood. He was a collector of books, an avid reader and writer, and a tireless worker for the things in which he believed. In 1946 he became Secretary of the Victorian Standing Committee on National Parks and National Monuments. He was responsible to this committee for drafting Victoria's National Parks Act, the first in Australia. His active commitment to national parks and inspirational leadership of the national park movement continued for more than 50 years, right up to the last. Just five months ago, in October 1997, he sent a strong message of support to a conference on 'The next Century of National Parks in Victoria' organised by the Victorian National Parks Association. His words to the Government and people of Victoria in 1996, in strong opposition to the proposed commercial developments at Wilsons Promontory National Park, were widely reported in '*The Age*', and made more poignant by the photograph of his pale and pillow-propped body which delivered the message. His eyes were bright, his smile was strong, the idea of compromise was not in his thoughts.

Ros Garnet is best remembered for his work on national parks; but he was also a great naturalist and conservationist, publishing many papers in *The Victorian Naturalist* and elsewhere, and writing on aspects of natural history for magazines and papers. He wrote several books, including wonderful descriptions of Wilsons Promontory and Wyperfeld National Parks. Ros was a member of the FNCV Council for 23 years from 1946–1969, and assumed the role of Secretary in 1946/47. He was President of the Club in 1948/49 and again from 1957–59. In 1966 he was awarded the Australian Natural History Medallion. In 1982 he was awarded Membership of the Order of Australia (AM) in recognition of his work in conservation and natural history.

His life virtually spans the twentieth Century. Born in Narracan on 13 August 1906, he attributed his love of nature to the early childhood years in south Gippsland and a headmaster who encouraged a great interest in nature study. In 1922, at the age of 16, he started work as a Laboratory Assistant in Melbourne. From 1924–1925 he was a Cadet in the School of Chemistry at the University of Melbourne, and qualified as an industrial chemist. In 1926 he joined the CSIRO Pulp and Paper Research Team, and then in 1928 moved to Port Pirie in the Commonwealth Quarantine Service. He returned to Melbourne in 1930 as a member of staff at the Commonwealth Serum Laboratories (CSL), retiring in 1971 after holding a range of research and senior administrative positions.

Ros Garnet was a man of action and a keen observer of nature. In 1918 he contracted poliomyelitis and as a consequence was somewhat physically handicapped - dependent on a stout walking stick for support. Like some others so afflicted (e.g.

Alan Marshall) he refused to let this physical defect constrain his activities; perhaps he gained strength and determination from it. In the 1920's he visited some of the remotest parts of Victoria on his bicycle, including Wilsons Promontory (1924), Mallacoota (1925), Lower Glenelg and Mount Gambier (1926). He was an active and determined camper and bush walker.

He married Elsie Don, a colleague in CSL, in 1935 and they collaborated in field work in the Dandenongs with particular interest in native orchids. Much of this work was published in the journals '*Wildlife*' and in '*The Victorian Naturalist*'. Elsie, who died last year, was a great support to Ros in his conservation work, and their two children, John and Joan, five grandchildren and a great grandchild, maintain a strong interest in the bush.

We salute our friend and conservation mentor, and commit ourselves to continue with his vision of purpose for the conservation and protection of the natural environment of Australia. We live in changing times with governments and the wider community re-thinking their approach to nature conservation and the management of national parks. We, with Ros Garnet, have seen the potential for conflict between the needs for environmental protection and other incompatible uses with clear commercial objectives. He embraced nature conservation and environment protection as legitimate forms of land use for their own sake. We must not let him down.

Malcolm Calder
Blackwood Hill, 375 Pinnacle Lane,
Steels Creek, Victoria 3775.

Flora and Fauna Guarantee Act 1988 Updates to Schedules 2 and 3

27 August 1996

Items added to Schedule 2 - List of Taxa and Communities of flora or fauna which are threatened.

Bardick *Echiopsis curta*
Quail, King *Coturnix chinensis*
Cassinia, Wrinkled *Cassinia rugata*
Greenhood, Desert *Pterostylis xerophila*
Pipewort, Southern *Eriocaulon australasicum*
Swainson-pea, Mountain *Swainsona recta*
Wattle, Jumping-jack *Acacia enterocarpa*
Warm Temperate Rainforest (East Gippsland Alluvial Terraces) Community

Dry Rainforest (Limestone) Community

Items Repealed from Schedule 2

Planarian *Spathula tryssa*

Items added to Schedule 3 - List of Potentially Threatening Processes.

Predation of native wildlife by the Cat Felis catus

28 November 1997

Items added to Schedule 2 - List of Taxa and Communities of flora or fauna which are threatened.

Egret, Little *Egretta garzetta nigripes*
She-oad Skink, Alpine *Cyclodomorphus praealtus*
She-oak Skink, Eastern *Cyclodomorphus michaeli*
Skink, Alpine Bog *Pseudemoia cryodroma*
Water Skink, Corangamite *Eulamprus tympanum marnieae*
Worm-lizard, Pink-tailed *Aprasia parapulchella*
Butterfly, Large Brown Azure *Ogyris idmo halmaturia*
Amphipod *Austrogammarus haasei*
Dandelion, Coast *Taraxacum cygnorum*
Orchid, Small Golden Moths *Diuris* sp. aff. *lanceolata*
Phebalium, Dainty *Phebalium obcordatum*
Rice-flower,Plains *Pimelea spinescens*
Wattle, Deane's *Acacia deanei* ssp. *deanei*
Zieria, Whorled *Zieria aspalathoides*

The Field Naturalists Club of Victoria Inc.

Established 1880

In which is incorporated the Microscopical Society of Victoria

OBJECTIVES: ***To stimulate interest in natural history and to preserve and protect Australian flora and fauna.***

Membership is open to any person interested in natural history and includes beginners as well as experienced naturalists.

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The Victorian Naturalist

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MEMBERSHIP

Members receive *The Victorian Naturalist* and the monthly *Field Nat News* free. The Club organises several monthly meetings (free to all) and excursions (transport costs may be charged). Field work, including botany, mammal and invertebrate surveys, is being done at a number of locations in Victoria, and all members are encouraged to participate.

SUBSCRIPTIONS RATES for 1998

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The Victorian Naturalist

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Welcome Merilyn Grey

We are pleased to welcome Merilyn as **Assistant Editor** for *The Victorian Naturalist*. Merilyn is a Ph.D. student at La Trobe University and her field of study is the influence of Noisy Miners on bird populations in remnants of Box-Ironbark Forest. Her previous experience includes several years working with the BHP Corporate Public Affairs Management Group. Merilyn's wide range of contacts in the biological field will be invaluable in her work with the journal.

Ed and Pat Grey
(any charges of nepotism will be denied)

Presidential Progress

At the Annual General Meeting, Professor Rob Wallis handed over the reins of the FNCV to Dr Tom May, mycologist at the National Herbarium, Melbourne.

Rob has presided over an exciting time for the club with the development of our Blackburn home; the joining of the Marine Research Group with the FNCV; the sale of the Kinglake block; the widening of club activities, and the training of volunteers.

We now look forward to Tom building on past good work, and wish him well. Tom is well known to members for his leadership of numerous fungi forays, and more recently in his role as chairperson of the Botany Group

Ed and Pat Grey and Merilyn Grey

Congratulations

Five members of the FNCV will receive Honorary membership this year:

Mr Leonard Angior
Miss Ruth Doig
Mr Jack Hyett
Mr Victor Jacobs, and
Mr Steve Marshall

Congratulations are extended to these long-standing members.

Thanks to:
Computer team - Alistair Evans, Anne Morton, who spend time every week preparing articles for the printers;
Address labels - Felicity Garde;
Web page - Michael McBain

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Assistant Editor: Merilyn Grey

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Cover: Mauve-tufted Sun Orchid *Thelymitra malvina* (see page 87). Photographed by John Eichler.

Find us on the WEB: http://calcite.apana.org.au/fncv/

First Record of *Gymnopaxillus* from Australia – A Rare Gasteroid Fungus

G. Crichton[1]

Abstract
This note presents an interesting record of a genus, *Gymnopaxillus*, found in Victoria which has not previously been recorded from Australia. (*The Victorian Naturalist*, **115 (3)**, 1998, 76-77).

Introduction

The order Gasteromycetes is a heterogeneous assemblage of unrelated genera. In particular, the 'gasteroid' forms, formerly placed alongside the puffballs and other 'gasteromycetes', are now placed with the Agaricales, Boletales and other orders, which mainly contain gilled fungi. The 'gasteroid' genera, including *Gymnopaxillus*, is considered to have evolved from agaricoid and puffball relatives.

In the early 1960s a new genus *Gymnopaxillus* Horak (Horak and Moser 1965) was described. This description was-based on the single species *G. morchellaeformis* Horak from Chile, South America. However, in June 1966, specimens of an apparently identical fungus were found on Junction Hill, Shire of Yea, Victoria. Although the Chilean fungi were found beneath the native beech *Nothofagus pumilio*, which could indicate a fairly moist climate, the local ones on Junction Hill were growing amongst native grasses beneath scattered Red Box *Eucalyptus polyanthemos* and Yellow Box *E. melliodora*. This area has 650–700 mm annual rainfall and is subject to hot, dry summers.

The specimens from Junction Hill were a light-yellow colour, growing above ground. Their most unusual characteristic was the lack of a peridium (outer edge); the surface having a morel or honey-comb appearance which felt dry and spongy.

Description

Gymnopaxillus morchellaeformis **Horak, in Horak and Moser(1965)**, *Nova Hedwigia* **10,** 335.

Macroscopic characters

Basidiocarps 20–25 mm wide, 25–30 mm high, globose to pyriform, epigean, uniformly light yellow, surface coarsely cellular (morchelloid), lacking any obvious peridium but traces present about the base of one specimen.

Stipe short, projecting 5–8 mm, attached to the soil by a bunch of coarse strands, completely immersed in the soil.

Columella, an extension of the stipe 0.5–0.66 mm into the gleba, attached throughout and with the end slightly dendroid, of a similar consistency to the stipe.

Gleba uniformly light-yellow, only slightly lighter in colour internally and unchanging upon sectioning, cells empty, course 1–2 mm, compressed, labyrinthiform, walls thin and with a tendency to radiate from the columella.

Microscopic characters

Peridium consisting of darkly, tinted, parallel hyphae, over a thicker layer of hyaline, swollen irregular, compressed cells

Stipe consisting of fine, 1.5–2 µm diam., closely parallel, septate hyphae.

Tramal plates, 140–220 µm thick, a palisade hymenium of basidia and sterile cells over a thin layer of hyaline, globose cells with the interior consisting of long, parallel, hyaline hyphae, 1.5–2.0 µm diam., with faintly tinted outlines, contents of basidia and paraphyses stain with cotton blue, while only the outer surfaces of the parallel hyphae do so.

Basidia 22 × 5.5 µm, hyaline, slightly clavate, bi-and tetra-spored, sterigmata to 6.5 µm, slightly curved, some with long thread to 11 µm.

Spores, 11–12.5 × 4.5–6 µm, boletiform (subfusiform), light-yellow tinted, smooth, inamyloid in Melzers solution, slightly darkened by Potassium Hydroxide (KOH), pedicel short cylindrical.

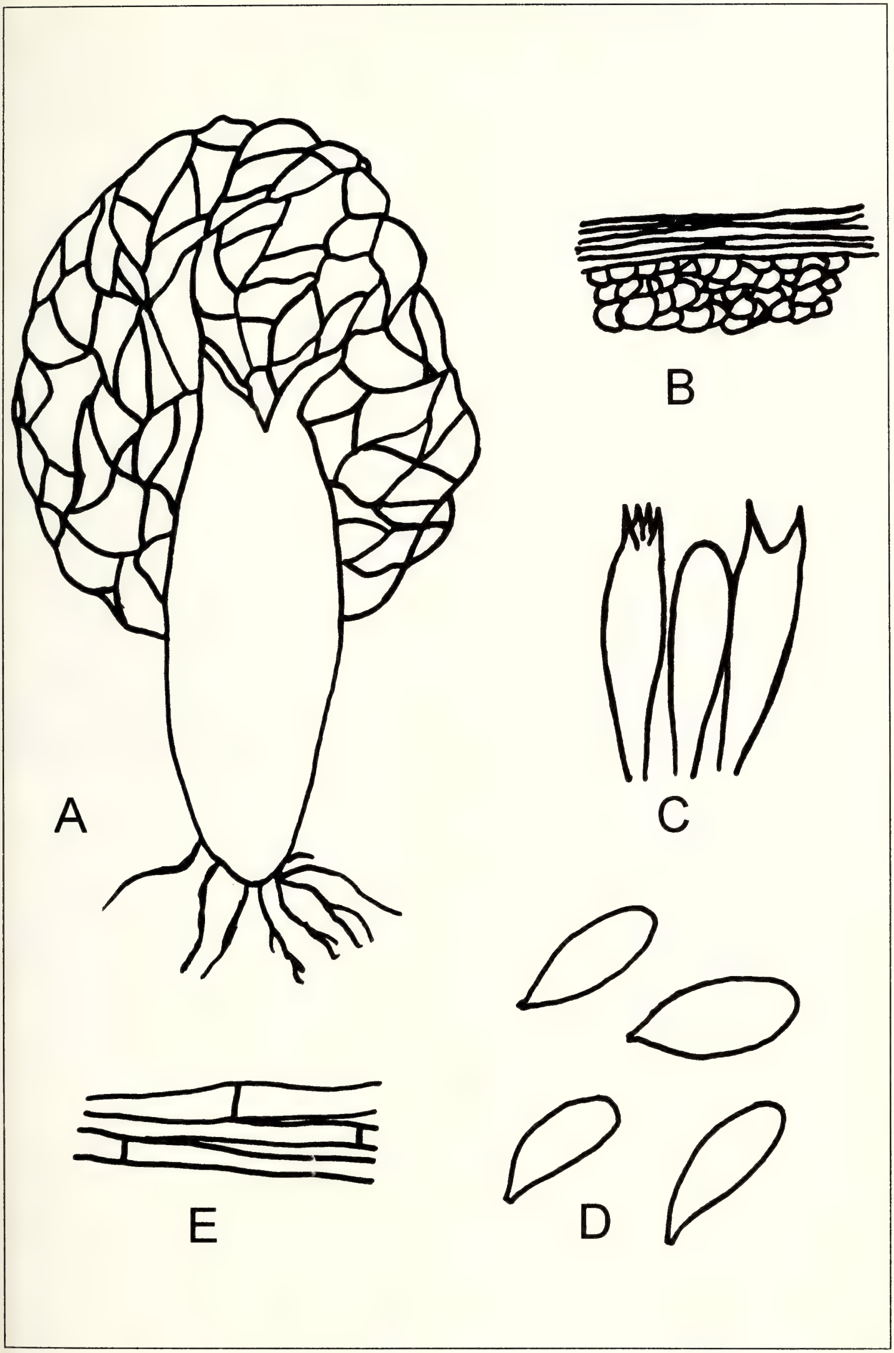
Collection examined

Victoria, Junction Hill, Shire of Yea, 24 June 1966, G.A. Crichton, D81. Collection deposited in MEL 2044316, ZT 2589.

Reference

Horak, E. and Moser, M. (1965). Fungi austroamericani VIII. Über neue Gastroboletaceae aus Patagonien: *Singeromyces* Moser, *Paxillogaster* Horak und *Gymnopaxillus* Horak. *Nova Hedwigia* **10**, 329-338.

[1] 6 Ainslie Park Avenue, Croydon, Victoria 3136.



Gymnopaxillus morchellaeformis **Horak.**
A: diagrammatic section of gasterocarp; **B**: section of peridium; **C**: hymenial section; **D**: basidiospores; **E**: structure of surface of stipe-columella.

Potential Competition for Nest Boxes Between Feral Honeybees and Sugar Gliders at Tower Hill State Game Reserve

Matthew S. Wood[1] and Robert L. Wallis[1]

Abstract

Sixty-seven nest boxes at Tower Hill State Game Reserve, Victoria, were examined for occupancy by feral Honeybees and Sugar Gliders. Twenty boxes were used by gliders and 18 by bees. There was no difference in preference by Sugar Gliders or Honeybees for either the type of tree species to which the box was attached, aspect of the entrance hole or the box diameter. However, Sugar Gliders preferred boxes attached higher in trees than did bees.
(*The Victorian Naturalist*, **115 (3)**, 1998, 78-80).

Introduction

Colonies of European Honeybees *Apis mellifera* that have escaped from hives often establish feral colonies in tree hollows and nest boxes where they compete with arboreal nesting mammals and birds (Oldroyd *et al.* 1994; Lawler *et al.* 1995). Bees can also feed on nectar and pollen and thus not only reduce the floral resources available to native animals (Pyke 1990; Wills *et al.* 1990; Paton 1993), but may also displace native pollinators (Pyke and Balzer 1985), although Paton (1996) has disputed the conclusions in this latter study.

The release of captive bred Sugar Gliders *Petaurus breviceps* into Tower Hill State Game Reserve began in 1979 and continued over three years. Nest boxes were provided because few naturally occurring hollows were present in this regrowth forest, following earlier clearing. Surveys of the population of gliders in the Reserve have been reported by Suckling and Macfarlane (1983) and Suckling and Goldstraw (1989), who found that the population had established and was using the nest boxes for shelter and breeding. In the latter study, however, 51% of the box-type nest boxes (as opposed to hollow limb structures) contained bee colonies.

In this paper we examine the use of nest boxes at Tower Hill by bees and Sugar Gliders and describe the characteristics of the boxes used by each of the species.

[1] School of Ecology and Environment, Deakin University, Rusden Campus, Clayton 3168.

Study site

Tower Hill is an extinct volcano located between Warrnambool and Port Fairy in western Victoria. The site and its management history have been described by Suckling and Macfarlane (1983). Three 'islands' exist within the lake of the crater. The clearing of trees on these islands began in the mid 1850s, and by 1870 the islands had no trees. However, since 1961 the site has been restored with extensive plantings of Manna Gum *Eucalyptus viminalis* and Swamp Gum *E. ovata*, as well as various wattles and other shrubs (Suckling and Goldstraw 1989).

Methods

Surveys were made in July 1996 of 67 nest boxes, erected in the work which commenced in 1979 on Main Island and Fairy Island. Nest boxes were located and marked on a base map. We used a ladder to gain access to the boxes and noted if bees or gliders were present. As well, we measured height, volume, entrance diameter and aspect of the entrance of the boxes, as well as the species of tree to which they were attached.

Thirty-three of the nest boxes were attached to Manna Gums, 29 to Swamp Gums, four to Black Wattle *Acacia mearnsii* and one to a Blackwood *A. melanoxylon*. The volumes of the nest boxes used varied from 9.9–27 litres (mean 10.9 ± 4.2). Most of the boxes faced north-east (18), east (17) or north (16). The remaining boxes (16) had aspects which were distributed evenly over the remaining directions. Most nest boxes (35) were between 3–4 m above the ground. Twenty-two were

between 4–5 metres off the ground and six were more than 5 m high. Three boxes had fallen on to the ground.

Frequencies of occurrence of Sugar Gliders and Honeybees were compared for each variable by Chi-square analysis (Fowler and Cohen 1990). In each case, the null hypothesis is that both species show the same preference for categories of the following variables:

- species of tree in which the nest box is located;
- entrance aspect;
- nestbox height;
- nestbox volume.

Results

Twenty of the 67 boxes were occupied by Sugar Gliders, 18 by feral Honeybees and the remainder were unoccupied. Table 1 presents the data showing the number of nest boxes containing Sugar Gliders and bees for three variables: tree species, aspect and height of box.

There was no statistically significant preference displayed by either Sugar Gliders (χ^2 = 2.6, P = 0.3) or bees (χ^2 = 3.2, P = 0.18) for either of the two eucalypt species. As well, neither Sugar Gliders (χ^2 = 5.6, P = 0.6) nor bees (χ^2 = 4.3, P = 0.75) showed any significant preference for boxes with any particular aspect.

Nest boxes ranged in height from 0–6.3 m (mean 3.79 ± 1.13). Sugar Gliders tended to select the highest hollows (χ^2 = 7.7, P = 0.17) (heights were categorised into six components at metre intervals) while bees showed less selectivity (χ^2 = 5.2, P = 0.39). Boxes used by bees were at a significantly lower height (3.5 ± 0.98 m) than those used by Sugar Gliders (4.5 ± 0.63 m) (T-test, P < 0.001; Mann-Whitney Test, 95% confidence intervals [0.4, 1.2], W = 513, P < 0.001). Table 1 suggests a preference by Sugar Gliders for boxes which were higher than 4 m off the ground. On the other hand, two boxes lying on the ground were being used by bees.

There was no significant difference in the mean volumes of boxes used by Sugar Gliders (10.5 ± 3.6 litres) (χ^2 = 3.5, P = 0.74) or bees (11.4 ± 4.8 litres) (χ^2 = 2.24, P = 0.89).

Table 1. Number of Sugar Gliders and feral Honeybee colonies found in nest boxes in Tower Hill State Game Reserve. (a) type of tree to which box was attached; (b) aspect of entrance to box; and (c) height at which box was attached to tree.

	Total	No. with Sugar Gliders	No. with Honey-bees
Total	**67**	**20**	**18**
(a) Tree species			
E. viminalis	33	11	9
E. ovata	29	8	5
A. mearnsii	4	0	2
A. melanoxylon	1	1	0
(b) Aspect			
North	16	6	5
North-east	18	3	5
East	17	7	4
South-east	4	1	1
South	3	2	0
South-west	3	0	3
West	3	0	0
North-west	3	1	0
(c) Height			
<1m	3	0	2
1-2m	1	0	0
2-3m	3	0	0
3-4m	35	5	14
4-5m	18	10	2
>5m	7	5	0

Discussion

Colonisation by feral Honeybees of nest boxes erected for marsupials has been reported elsewhere (Wood 1996; Irvine and Bender 1997) and can impede efforts for the re-introduction of species into restored habitat. This study has found there was considerable overlap in the characteristics of nest boxes occupied by Sugar Gliders and bees, with the height of attachment being the only measurable difference. Menkhorst (1984) has also reported that Sugar Gliders near Lindenow in Gippsland had a significant preference for use of boxes high off the ground.

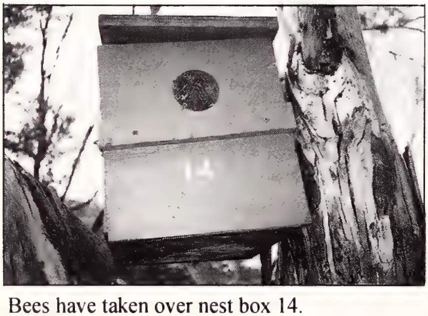
In 1986, at Tower Hill, 30 boxes contained Honeybees (Suckling and Goldstraw 1986) compared with 18 boxes found, ten years later, in this study. In 1996 the density of bee colonies on Main Island was 0.14/ha. This density of bee colonies is still much lower than that reported in Wyperfeld National Park (1.11/ha) by Lawler *et al.* (1995) and in You Yangs Regional Park (1.66/ha) by Wood (1996).

Since most of the vacant boxes found on

Main and Fairy Islands were fairly low to the ground they would be more suitable for occupation by bees than by Sugar Gliders. Therefore, given the high number of colonies of bees still using nest boxes, it may be necessary to remove these colonies and restore the boxes (Paton 1996) and then to prevent future access by bees using the techniques described by Irvine and Bender (1997).

The characteristics of nest boxes used by bees in our study are typical of those reported for hollows used by bees elsewhere. The volume of hollows used is mostly between 20–80 litres (Seeley 1985). Most hollows are above 3 m off the ground, even though bees have been recorded nesting in a range of heights (Avitabile *et al.* 1978). The entrance area of Honeybee nests rarely exceeds 75 cm^2 (the nest boxes we examined had entrances of 20 cm^2) and overseas, bee nest sites show a weak preference for a southerly facing aspect (Avitabile *et al.* 1978), although no equivalent preferences (for north-facing entrances) have been reported in Australia (Oldroyd *et al.* 1994; Wood 1996).

We conclude that colonies of feral Honeybees and Sugar Gliders show considerable overlap in preference for nest boxes in terms of the species of tree to which the box was attached, aspect of the box entrance, and volume of the box. However, there was a significant difference in the heights of the boxes chosen by the two species, with Sugar Gliders preferring boxes at higher sites than feral Honeybees. As most of the unoccupied boxes were fairly low to the ground, they favoured potential occupancy by bees instead of Sugar Gliders.



Bees have taken over nest box 14.

Acknowledgements

We wish to thank Ranald Anderson and Stuart Willsher, rangers at Tower Hill State Game Reserve for their assistance in this study.

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A Note on Bait Selection when Trapping the Swamp Skink *Egernia coventryi* in Elliott Traps

Nick Clemann[1], Peter Brown[1] and Geoff Brown[2]

Abstract
The Swamp Skink *Egernia coventryi* is a rare lizard that, because of the the dense vegetation it typically inhabits, is difficult to survey using conventional hand-capture techniques, but may be captured using Elliott traps. In the past researchers have used a mixture of peanut butter, rolled oats and honey as bait in these traps. This paper compares this bait with fresh pilchards as bait during preliminary surveys for *E. coventryi* at sites at the Royal Botanic Gardens, Cranbourne and the Hastings-Bittern Coastal Wetlands in southern Victoria. Despite small sample sizes, the pilchards appeared to increase trap success, and should be considered as a standard survey technique when surveying for this lizard. (*The Victorian Naturalist*, **115 (3)**, 1998, 81-83).

Introduction

The Swamp Skink *Egernia coventryi* is an uncommon scincid lizard occupying disjunct swamp and saltmarsh habitat in south-eastern Australia (Fig. 1). Classified as rare in Victoria (CNR 1995), relatively little is known of its biology and ecology, although population monitoring is being conducted at Tootgarook Swamp in conjunction with captive management of *E. coventryi* at Healesville Sanctuary (Taylor 1994). *E. coventryi* is habitat specific and may be locally common at some locations (e.g. Tootgarook Swamp and the Hastings-Bittern Coastal Wetlands). At saltmarsh habitat where this lizard occurs with driftwood it is relatively easy to locate (Schulz 1985), however, in areas with small amounts of litter or other ground debris, trapping is the most effective survey technique (Robertson 1980; Schulz 1992).

Due to the retiring nature of *E. coventryi* and the dense vegetation this lizard typically inhabits, conventional hand-capture techniques are relatively ineffective (Robertson 1980; Schulz 1992; Douch 1994). The capture of *E. coventryi* has been most successful when Elliott aluminium traps (33 x 10 x 9 cm) baited with a mixture of rolled oats, peanut butter and honey were used (Robertson 1980; Schulz 1992; Douch 1994). Robertson (1980) in particular, noted that, when weather conditions and choice of trap position are suitable (i.e. in microhabitat used by *E. coventryi*), *E. coventryi* readily enters Elliott traps and consumes this bait.

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Study Site

During the summer of 1996-97 a study of the habitat of *E. coventryi* was undertaken at three sites in southern Victoria. Trapping for *E. coventryi* was conducted on saltmarsh (dominated by Swamp Paperbark *Melaleuca ericifolia*, Saltbush *Arthrocnemum arbusculum*, Beaded Glasswort *Sarcocornia quinqueflora*, Chaffy Saw-sedge *Gahnia filum* and Prickly Spear-grass *Stipa stipoides*) adjacent to the boardwalk in the Hastings-Bittern Coastal Wetlands (HBCW) on the eastern shore of Mornington Peninsula in Victoria, and at two sites in the Royal Botanic Gardens, Cranbourne (RBGC). The vegetation at the Cranbourne sites was dominated by Soft Twig-rush *Baumea rubiginosa*, Bog Rush *Schoenus* sp., Prickly Tea-tree *Leptospermum continentale*, Pale Leaf-rush *Juncus pallidus*,

Fig. 1. *Egernia coventryi* at Cranbourne Botanic Gardens. Photo Nick Clemann.

Thatch Saw-sedge *Gahnia radula*, Scented Paperbark *Melaleuca squarrosa* and Zig-zag Bog-rush *Schoenus brevifolius*.

Methods

A pilot study was undertaken at the three study sites in mid-December 1996 to determine the ease with which *E. coventryi* could be captured. In the first trapping, period all Elliott traps at the three sites were baited with rolled oats, peanut butter and honey, and positioned on, or adjacent to, locations where *E. coventryi* was observed. At the RBGC, 25 traps were placed in and below vegetation on the perimeter of a pond in the 'Australian Garden' where several *E. coventryi* had been observed basking. A further 23 traps were placed in and below vegetation at sites adjacent to the fence-line on the eastern boundary of the RBGC. This area had been successfully sampled for *E. coventryi* in 1981 (P. Robertson *pers. comm.*), and several individuals were observed by the authors prior to trapping.

A similar effort was undertaken at the HBCW. In late December, 34 traps, similarly baited, were placed at sites adjacent to the 'Wetland Walk' in habitat where *E. coventryi* had been observed. Further trapping was undertaken in January 1997 at the three sites to trial pilchards as an alternative bait.

Results and discussion

Despite three days trapping in December (144 trap-days), no specimens of *E. coventryi* were captured in the RBGC. The weather during this period was cool, with a maximum temperature of approximately 21°C, and overcast. Many of the traps became infested with ants, and the lizards may have avoided these traps.

In the HBCW, over the three days trapping (102 trap-days), only one adult *E. coventryi* was captured. During this period the weather was fine, with sunny conditions and temperatures ranging from 19–27°C. Numerous *E. coventryi* were observed during these days, including several in close proximity to trap positions.

Thus, these preliminary trapping sessions returned a single capture for an effort of 246 trap days, a trapping-rate deemed unsatisfactory for the project, particularly when basking and active individuals had been encountered at all sites during the period.

In an attempt to improve trapping success, a different bait was trialled. During the second trapping exercise in early January 1997, traps at each site were laid in pairs. Each pair consisted of one Elliott trap baited with a mixture of rolled oats, peanut butter and honey, and the other baited with a piece of fresh pilchard. At the RBGC, 14 traps (7 pairs) were laid around a small swamp on the northern fence-line of the RBGC, and 34 traps (17 pairs) were positioned on the eastern fence-line. Simultaneously, the HBCW were sampled using pairs of traps at the original twenty-three sites. All traps were checked twice daily over three days.

During this trapping period the weather was cool and fine, with temperatures ranging from 18–20°C. A total of 282 trap days (144 at the RBGC, 138 at the HBCW) yielded 14 adult *E. coventryi*. Six were caught at the RBGC (five in traps containing pilchards, one in a trap containing standard bait), and eight were caught at the HBCW (six in traps containing pilchards, and two in traps containing standard bait).

Based on these results the pilchards were deemed more successful than the standard bait, and it was considered possible that those individuals captured in traps containing the standard bait may have been drawn to these traps by the odour of the pilchards in the adjacent trap. Although the small sample sizes demand careful interpretation, further trapping later in the season confirmed the usefulness of this bait, with some traps yielding successive captures of different *E. coventryi* over several days, and several recaptured individuals.

Elliott traps baited with pilchards also proved enticing to small mammals at these sites, with numerous Swamp Rats *Rattus lutreolus* (20 at RBGC and seven at HBCW) and House Mice *Mus musculus* (15 at RBGC and 10 at HBCW) being trapped over the duration of the study, as well as five Agile Antechinus *Antechinus agilis* trapped at the HBCW.

Further trials using pilchards to trap larger samples of *E. coventryi* would be desirable, but these results suggest that this lizard appears to have a greater preference for Elliott traps baited with pilchards compared

with the standard bait of peanut butter, rolled oats and honey. It is recommended that, in future surveys investigating the presence of this rare skink in potentially suitable habitat, the baiting of Elliott traps with pilchards be adopted as a standard survey technique.

Acknowledgments

The staff of the Royal Botanic Gardens, Cranbourne, provided assistance and direction during fieldwork. Peter Robertson provided advice on field technique and locations of Swamp Skink populations. Malcolm Legge discovered the Swamp Skink population on the Hastings-Bittern Coastal Wetlands. This study was made possible by a generous grant from the Peter Rankin Trust Fund for Herpetology. Trapping was conducted under the DNRE Flora and Fauna Permit No. RP-96-198, and the approval of the Deakin University Animal Ethics Committee (Approval No. A18/96). An anonymous referee greatly improved the original manuscript.

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Red Fox Takes Little Raven

Early on 22 February 1997, while undertaking a waterfowl count at Lake Kariah, about nine km north east of Camperdown in Western Victoria, I noticed that several species of water birds that had been loafing on the lake edge all moved into the lake and swam off. Because I had been observing them for some time from about 300 m away using a zoom telescope, I thought it unlikely I had disturbed them. Visibility was good and there was little wind.

I scanned back to the lake edge and noticed a Red Fox *Vulpes vulpes* sitting near the water's edge. It sat for a short time then turned and ran into grass behind it. A Brown Hare *Lepus capensis* bolted from the grass, through a fence and then stopped some metres away watching the fox.

The fox sat near the fence, then crouched and ran along the fenceline in a crouching gait for about 20 m and caught a Little Raven *Corvus mellori* by a wing as the bird tried to fly off. While grasping the wing, the fox spun around doing two complete circles while shaking the bird. The fox then put the raven on the ground and was pecked on the face; the fox then grabbed the raven and shook the bird vigorously a few times and then walked through a fence to the adjoining paddock, escorted by about 20 Little Ravens. It stopped and began to eat the bird, giving the carcase occasional vigorous shakes. After about five minutes the fox took a piece of the raven, walked off some metres and appeared to cache the material. It then returned to the carcase and continued feeding.

Twelve minutes after catching the raven, the fox returned to the cached item and ate it. It then collected the carcase, and moved off, occasionally stopping to chew on it, all the time being mobbed by ravens.

About 25 minutes after the kill, the fox dropped the remains and slowly walked away, stopping occasionally to look around. A few minutes later it jumped onto a dump of silage bales wrapped in plastic, that were about 400 metres from the wetland. It walked to the centre of the dump, jumped down into a gap in the bales and disappeared from view. Life on the lake and pastures returned to normal. The hare had not moved.

Acknowledgement

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The Biogeography of *Pseudocephalozia paludicola* R.M. Schuster; an Endemic Australian Liverwort

Jon Sago[1]

This article is dedicated to the memory of Dr. George Scott who inspired a generation of Victorian bryologists.

Abstract
The subalpine endemic liverwort *Pseudocephalozia paludicola* R.M. Schuster is confined to the Baw Baw Plateau and Mt Torbrek in Victoria and Mt Rufus in Tasmania (Fig. 1). Palaeogeological evidence indicates that the genus has its origins in the Tertiary, and its current distribution may be explained by the breakup of the Gondwana supercontinent 300 million years ago, and the constraints of a relatively warmer climate and the consequent dwindling of subalpine vegetation.

(*The Victorian Naturalist*, **115 (3)**, 1998, 84-86).

Pseudocephalozia paludicola R.M. Schuster is a small leafy and intercalary branched liverwort in the family Lepidoziaceae. The concave, quadrifid leaves are transversely to slightly succubously inserted. The underleaves are tri- or quadrifid, and vary from very small to almost as large as the lateral leaves. The perianth is ca. 0.2×0.25 mm and appears on short basal stems (after Scott 1985). The thread-like shoots grow up to 4-5 cm, forming condensed interwoven pale blue-green wefts (Fig. 2). The older decayed shoots are cork-like when desiccated.

The species is an Australian endemic (Scott 1985; Schuster and Engel 1974) with its primary centre of distribution in Victoria. Within Victoria, *P. paludicola* has been found only three times on the Baw Baw Plateau, 300 km to the east of Melbourne, in the last fifteen years: Mt Baw Baw, Mt St Gwinear and Mt Erica. (A. Theis and G. Scott *pers. comm.*). Each findspot is over 1500 m in altitude. It has recently been located at Mt Torbrek, 200 km to the north of its previous known distribution, at 1480 m. Outside Victoria it has been observed only once (Fig. 1), in central Tasmania, directly west of Lake St Clair, on Mt Rufus, the type location (Schuster and Engel 1974).

In Victoria, *P. paludicola* grows on rock surfaces located amongst rocky outcrops in sub-alpine *Eucalyptus pauciflora* grassy woodlands above 1450 m. The vegetation of the Tasmanian site is described as sub-alpine, dominated by *Eucalyptus coccifera* (Schuster and Engel 1974). On Mt Torbrek it is associated with the lichens *Parmelia signifera* and *Pseudocyphellaria crocata* and the mosses *Bartramia hallerana* and *Grimmia trichophylla,* inhabiting a sheltered rock ledge with a south-western aspect.

Geologically, all the Victorian locations (including Mt Torbrek) share a common origin. They are categorized as belonging to the 'Baw Baw Surface', a Paleocene peneplain, the oldest preserved erosion surface in eastern Victoria (Jenkin 1976),

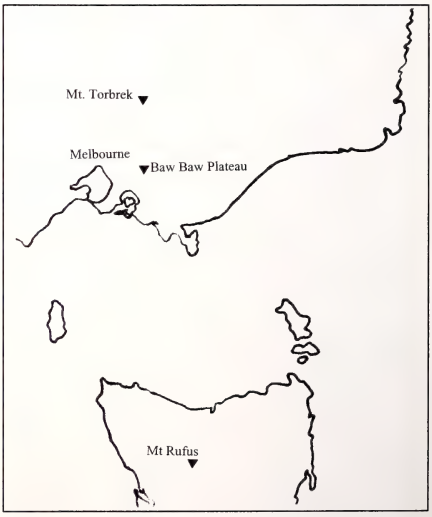

Fig. 1. Map of five known locations of *Pseudocephalozia paludicola.*

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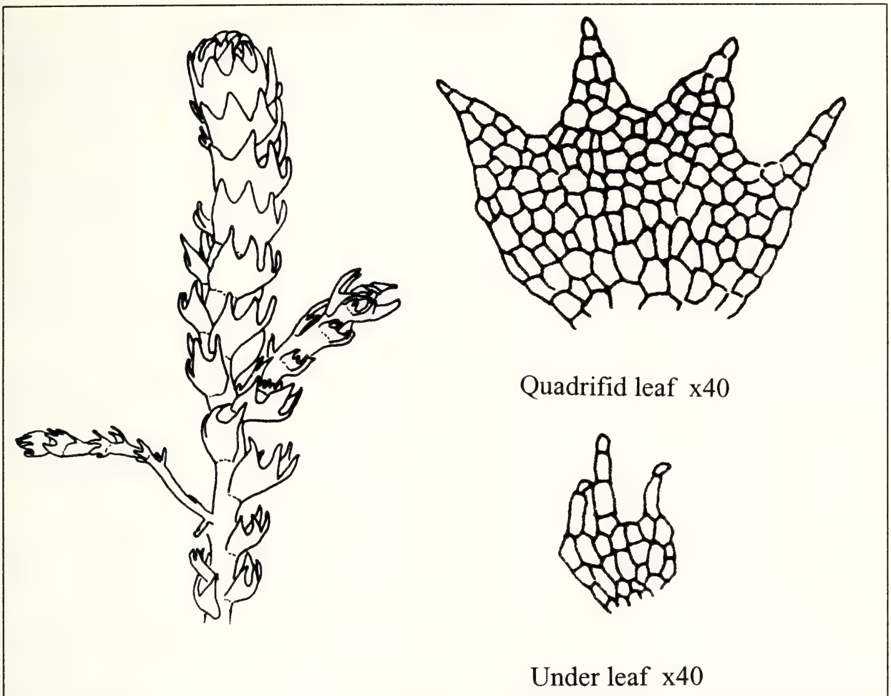

Fig. 2. Shoot (x 16.5) and leaves of *Pseudocephalozia paludicola* R.M. Schuster.

which formed under the sea, and slowly uplifted during the Tertiary period. Moreover, all the findspots occur literally on the highest peaks extant within this geological structure. The Mt Rufus site is similar, in that, geologically, it is composed of the oldest erosion surface within Tasmania (Davies 1959).

Such altitudinal preferences are also found in another species of the genus: *Pseudocephalozia quadriloba* (Steph.) Schust. This liverwort may be encountered in disjunct sites at high elevation along the spine of the South American cordillera (Schuster and Engel 1974; Engel and Smith-Merrill 1997).

A possible explanation for the contemporary geographical distribution of *P. paludicola*, is that the species physically separated during the Jurassic on Gondwanan fragments. This includes Tasmania, which pulled apart from the Australian mainland forming the Bassian Basin during this period (Dettmann *et al.* 1992).

All four known examples of *P. paludicola* are small solitary colonies. Both the Mt Erica and Mt Torbrek individual plants are restricted to small discrete patches less than 20 cm in diameter and consequently a random catastrophic event such as bushfire could lead to its elimination. It is also important to note that the current climate, and that of probably the last 4000 years has been less than optimum for this species, as alpine and sub-alpine vegetation has been on the decline, and now Alpine vegetation in Australia consists of only 1% of that reached at maximum extent of glaciation (approx 15,000 b.p.) (Kirkpatrick 1997).

Whilst the Baw Baw individuals possess sporophytes and are capable of reproduction and dispersion by spore, the Mt Torbrek specimen lacks fruiting bodies and its only method of regeneration is vegetative. Furthermore, it has a greater tendency for more succubous leaf insertion than the type description, indicating that the genus *Pseudocephalozia* R.M.Schuster is not as tightly circumscribed as has been previously considered (G.Scott *pers. comm.*), and there is much genetic variation within the taxon which has not been accounted for taxonomically.

Pseudocephalozia paludicola has not been observed at other sites of similar geology or climate in southern Australia despite a generation of botanical exploration. It was not located at Lake Mountain (1480 m) during a recent cryptogam survey (Jelinek *et al.* 1997) and, despite a thorough search by the author in April 1997, was not observed at Mt Donna Buang (1350 m). It is apparent that an altitude >1450 m is the salient factor in the liverwort's distribution.

Pseudocephalozia paludicola is considered to have a conservation status of Vulnerable (Scott *et al.* 1977). The Mt Erica and Mt St Gwinear sites are conserved within the Baw Baw National Park, though recreational pressure in the form of skiing or insensitive construction of, say, a hut or walking track may pose a threat. The Mt Baw Baw site lies within the Baw Baw Ski Village which was excised from the National Park by the Alpine Resorts Act (1983) and any individual *P. paludicola* plant which has survived the ravages of tourism does not enjoy theprotection offered by a National Park. The Mt Torbrek site is not conserved, lying outside the adjacent Lake Mountain Conservation Zone. This site is also subject to the recreational pressure of bushwalking and sightseeing.

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Rare Orchids in the Nyora Area, Victoria

A number of orchids of regional, as well as State, significance occur in the Nyora area of Gippsland, Victoria. In particular, an area of public land, approximately three kilometres west of Nyora, supports several such plants. This area was recently recommended to be made a Nature Conservation Reserve by the former Land Conservation Council, after submissions from, among others, the Field Naturalists Club of Victoria (FNCV).

Our visits to the area commenced in October 1991 and regular visits over the ensuing years have revealed the following orchid species of State significance - Orange-tip Caladenia *Caladenia aurantiaca*, Green-striped Greenhood *Pterostylis chlorogramma*, Superb Greenhood *P. grandiflora* and Mauve-tufted Sun Orchid *Thelymitra malvina*. The following orchids at Nyora are of regional significance - Mayfly Orchid *Acianthus caudatus*, Elbow Orchid *Arthrochilus huntianus*, Bronze Caladenia *Caladenia iridescens*, Large Duck Orchid *Caleana major*, Small Duck Orchid *C. minor*, Small Helmet Orchid *Corybas unguiculatus*, Bearded Midge Orchid *Genoplesium morrisii* and Horned Orchid *Orthoceras strictum*.

The area also supports a number of other vascular plants that are of regional significance, namely the Heath *Epacris gunnii* and Hairy Pink-bells *Tetratheca pilosa*, and in April 1992 the interesting discovery of an undescribed *Hypocreopsis* species, a new fungal genus for Australia, was made. (See May and Eichler 1993).

Undoubtedly comprehensive surveys of the area, done at regular intervals throughout the year, will reveal further significant orchid species as well as other vascular and non-vascular plants.

The Botany Group of the FNCV has visited the area on two occasions, in June 1993 and October 1997. The purpose of the first visit was to record fungi, and a tentative species list has been prepared in which a number of apparently uncommon fungi were noted. The purpose of the second visit was to record orchids. However, conditions were very dry and no additions were made to the following list prepared by the authors.

Orchid List

Names follow Backhouse and Jeanes (1995).

Mayfly Orchid *Acianthus caudatus*,
Small Mosquito Orchid *A. pusillus*,
Elbow Orchid *Arthrochilus huntianus*,
Orange-tip Caladenia *Caladenia aurantiaca*,
Bronze Caladenia *C. iridescens*,
Large Duck Orchid *Caleana major*,
Small Duck Orchid *C. minor*,
Red Beard Orchid *Calochilus paludosus*,
Purple Beard Orchid *C. robertsonii*,
Autumn Bird Orchid *Chiloglottis reflexa*,
Common Bird Orchid *C. valida*,
Small Helmet Orchid *Corybas unguiculatus*,
Large Tongue Orchid *Cryptostylis subulata*,
Small Gnat Orchid *Cyrtostylis reniformis*,
Rosy Hyacinth Orchid *Dipodium roseum*,
Parson's Bands *Eriochilus cucullatus*,
Bearded Midge Orchid *Genoplesium morrisii*,
Wax-lip Orchid *Glossodia major*,
Horned Orchid *Orthoceras strictum*,
Green-striped Greenhood *Pterostylis chlorogramma*,
Superb Greenhood *P. grandiflora*,
Tall Greenhood *P. longifolia*,
Nodding Greenhood *P. nutans*,
Tiny Greenhood *P. parviflora*,
Pink Sun Orchid *Thelymitra carnea*,
Spotted Sun Orchid *T. ixioides* var. *ixioides*,
Mauve-tufted Sun Orchid *T. malvina* (see Front Cover),
Slender Sun Orchid *T. pauciflora*,
Salmon Sun Orchid *T. rubra*.

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Use of Tracks and Trails by Introduced Predators: an Important Consideration in the Study of Native Ground-dwelling Mammals

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Abstract
While investigating the ecology of native ground-dwelling mammals at a forested site in south-eastern mainland Australia, I found that foxes and cats were using trap-lines established through previously dense understorey vegetation. On several occasions study animals captured in baited traps were attacked and/or killed by these introduced predators. The distances that foxes moved along trap-lines from the main access road leading into the site were up to 490 m, while evidence of cats was found up to 300 m down trap-lines. Poison laid at the head of each trap-line on the main access road resulted in the removal of problem foxes for over 14 months. However, predation by cats on small mammals continued during the same period. This study demonstrates that introduced predators will take advantage of localised loss of thickets of vegetation, using newly-formed openings in the understorey as movement corridors. In view of this finding, there are some implications for wildlife researchers intending to study native ground-dwelling mammals, and for land management agencies attempting to conserve these animals in multiple-use forests. (*The Victorian Naturalist*, **115 (3)**, 1998, 88-93).

Introduction

In Australia the use of native fauna as food by the Red Fox *Vulpes vulpes*, dog *Canis familaris* and European Cat *Felis catus* is well documented (Jones and Coman 1981; Triggs *et al.* 1984; Catling 1988; Kinnear *et al.* 1988; Brown 1989; Lunney *et al.* 1990). In some instances these introduced predators have been either partially or entirely responsible for the demise and/or extinction of populations of ground-dwelling mammals (Kinnear *et al.* 1988), particularly those in the critical weight range 35–5500 g (Burbidge and McKenzie 1989; Johnson *et al.* 1989). A number of authors (reviewed by May and Norton 1996) have suggested that introduced predators forage more efficiently for native mammals in fragmented or recently disturbed habitats, but empirical evidence to support this notion is limited to studies undertaken overseas in markedly different habitats to those occurring in Australia (i.e. Angelstam 1986; Andren and Angelstam 1988). Locally, there is a wealth of information to show that foxes, dogs and cats use tracks and trails as movement corridors (May and Norton 1996), although no previous studies have demonstrated unequivocally that these predators will exploit localised increases in the abundance of tracks and trails for hunting and acquiring prey. In the study described here, I document such behaviour by foxes and cats which were found to use trap-lines established to monitor a native ground-dwelling mammal community at a forested site in south-eastern mainland Australia.

Methods

Details of the study site have been presented elsewhere (Claridge *et al.* 1993a, 1993b). Briefly, it comprised a 100 ha area of forested catchment approximately 4 km east of the settlement of Cabbage Tree Creek, East Gippsland, Victoria (148°47'25E, 37°04'40S). Overstorey vegetation at the site is dominated by Silvertop Ash *Eucalyptus sieberi*, Yellow Stringybark *E. muelleriana* and White Stringybark *E. globoidea* on the slopes and ridges, and by Mountain Grey Gum *E. cypellocarpa* and Southern Mahogany *E. botryoides* in the gullies. Understorey vegetation is uniformly dense across the site, forming an almost impenetrable thicket: the most common plant species being Handsome Flat Pea *Platylobium formosum*, Forest Wiregrass *Tetrarrhena juncea* and sedges (Stuwe and Mueck 1990).

A trapping grid was established at the study site to capture native ground-dwelling mammals (Claridge *et al.* 1993a). Wire cage traps (Mascot Wireworks) were placed in a grid of 10 parallel rows with 10 trap sites on each

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row. Each row extended into the forested catchment from Falls Creek Track No. 1, a main access road into the general study area. Distances between trap sites in each trap-line were not uniform (25–100 m), but rather spread evenly among five aspect-slope topographic combinations: (1) ridge-sheltered (easterly) aspect; (2) mid-slope-sheltered aspect; (3) gully; (4) mid-slope-exposed (westerly) aspect; (5) ridge-exposed aspect. Rows of traps were separated by a distance of at least 100 m. Ground-dwelling mammals were live-trapped on 12 occasions between January 1990 and January 1992. During each trapping session traps were set for between two and 10 days, but never for more than four consecutive days and each trap was baited with a mixture of rolled oats, peanut butter and pistachio essence (Scotts and Seebeck 1989). Traps were re-baited in the afternoon (15:00–18:00 hrs) and checked the following morning (06:00–09:00 hrs).

Eleven different species of mammal were caught during the study: the Long-nosed Potoroo *Potorous tridactylus*, Long-nosed Bandicoot *Perameles nasuta*, Southern Brown Bandicoot *Isoodon obesulus*, Common Brushtail Possum *Trichosurus vulpecula*, Mountain Brushtail Possum *Trichosurus caninus*, Ring-tailed Possum *Pseudocheirus peregrinus*, Short-beaked Echidna *Tachyglossus aculeatus*, Bush Rat *Rattus fuscipes*, Swamp Rat *Rattus lutreolus*, Red Fox and European Cat. Details of the trapping results will be provided in a later publication.

Results and Discussion

Establishment of the trapping grid at Cabbage Tree Creek involved (along all trap-lines) removal of dense thickets of understorey vegetation, which was generally beaten down by foot after being cut by a machete. At the end of the first trapping session (January 1990) all trap-lines into the site were formed, comprising narrow (1–2 m wide) tracks with tall (1–2 m) and extremely thick vegetation either side. In the next trapping session (February 1990), it was apparent that foxes were using trap-lines as movement pathways: tracks were noted leading from the main access road down three of 10 trap-lines, together with the characteristic musky odour of fox. In one of the trap-lines this resulted in the attack and killing of a Long-nosed Potoroo, which had been captured in a wire cage trap (Table 1). Shortly after, in the same trapping session, the fox, presumably responsible for killing the potoroo, was captured in the same trap and removed off-site. However, utilisation of other trap-lines by foxes continued during the next three trapping sessions, between May and September 1990, resulting in killing of a further three potoroos, a Southern Brown

Table 1. Use of trap-lines established to monitor native ground-dwelling mammals by the fox (*Vulpes vulpes*) and cat (*Felis catus*) at Cabbage Tree Creek, East Gippsland, Victoria, during the period January 1990 to January 1992.
Key: * = 1080 poison-baiting campaign undertaken at end of trapping session (see text). ** = number of trapping-lines on which evidence of cat or fox was found. *** = distance along trapping-line from main access road. # = animal attacked rather than killed. A = *Antechinus swainsonii*, I = *Isoodon obesulus*, R = *Rattus fuscipes*, L = *Rattus lutreolus*, P = *Potorous tridactylus*. Numbers in circular brackets ( ) refer to number of animals of that particular species attacked or killed by either foxes or cats during that trapping session.

	Date												
Observation	Jan 1990	Feb 1990	May 1990	Jul 1990	Sep* 1990	Nov 1990	Jan 1991	Mar 1991	May 1991	Jul 1991	Sep 1991	Nov 1991	Jan 1992
No. Cat kills or attacks	-	-	-	-	2	-	1	1	1				
No. Fox kills or attacks	-	1	1	3	1	-	-	-	-	-	-	-	1
Evidence of Cat**	-	-	-	-	2	-	-	-	1	1	1	-	-
Evidence of Fox**	-	3	1	3	1	-	-	-	-	-	-	-	5
Mammal species attacked or killed by Cat	-	-	-	-	A (2)	-	-	-	L(1)	R(1)	R(1)	-	-
Mammal species attacked or killed by Fox	-	P(1)	I(1)	P(2)	P (1)	-	-	-	-	-	-	-	P(1)
Distance along trap-line of attack or kill (m)***	-	33	98	84 185 493	100 120 295#	-	-	-	193	274	300	-	210

Bandicoot and a Bush Rat (each identified from remains). All mammals preyed on were killed either during, or after, removal from traps by foxes. Around each disturbed trap there was a strong odour of fox.

The removal of native animals from traps by foxes was very characteristic. In all cases, disturbed traps were turned on their side, causing the wire bar that locks the trap door shut to slide out of place, thereby causing the trap door to open. Disturbed traps were moved distances up to 1 m from their site of placement. The soil under the position where disturbed traps were originally placed was excavated to depths exceeding 40 cm.

Evidence of cats using trap-lines came much later during the study. In September 1990, two dead adult female Dusky Antechinus *Antechinus swainsonii* were found on two trap-lines. The body of each animal was reasonably intact, complete with litters of six and eight young, respectively. The head of one of the adult animals had been removed completely, while the other adult animal had a broken neck. On one of the trap-lines where a dead antechinus was found, a female sub-adult cat was captured within 25 m of the kill-site, the same day. During the same trapping session, another two antechinus carcasses, with similar wounds to those described above, were collected along Falls Creek Track No. 1. Cats also killed native mammals along trap-lines during three other trapping sessions, between May and September 1991: in each case a Bush Rat or a Swamp Rat had been killed while captured in a cage trap (Table 1). The attack and killing of captured native mammals by cats was distinctive. On the 3 occasions where rats were preyed on, the captured animals remained locked in the cages and rather than disturbing the traps like foxes, cats were able to secure captured animals while they were still trapped. After securing their prey most of it was consumed on-site. There was a distinctive smell of cat urine around each trap where such activity had taken place.

At the end of the trapping session in September 1990, I decided to reduce predation pressure on native mammals at the site by undertaking a poison-baiting campaign using the toxin 'Compound 1080' (King *et al.* 1985) to eradicate the problem. With the assistance of officers from the (then) Department of Conservation, Forests and Lands, a poison-baiting program was undertaken throughout October and early November 1990. This involved setting up a series of bait stations situated at the head of each trap-line, where they adjoined the main access road into the study site. There were 10 such stations across the width of the trapping grid (100–200 m spacing), and a further 20 stations spread evenly (400–500 m spacing) at each end of the trapping grid, all along Falls Creek Track No. 1. Each station comprised a mound of river sand, approximately 1 m in diameter. For the first two weeks a 'free-baiting' trial was undertaken. This involved placing two pieces of non-poisoned bullock liver into small excavations in each mound, covering over the baits with more sand, and then smoothing the mound over using a rake. All mounds were checked from a vehicle each day, between 08:00–10:00 hrs and between 15:00–17:00 hrs. Baits taken by introduced predators were replaced immediately, and the tracks of those predators identified (where possible) to species level. After two weeks of 'free-baiting' it was clear that: (i) no native animals were taking baits, and (ii) that the number of 'takes' by introduced predators had reached a plateau high-point. At that time, all non-poisoned baits were replaced with baits laced with an appropriate dose of Compound 1080 (McIlroy 1981). Poison-baiting continued regularly for the next three weeks, by which time no baits were being eaten.

Only foxes, cats and dogs/dingoes visited the bait stations during October and early November 1990. Two of these species, the fox and the dog, consumed poisoned baits and it soon became clear that the problem fox/foxes had been killed because in the following trapping session (late November 1990) no captured native mammals were predated on by foxes. The same trend continued for the next six trapping sessions (Table 1). It was not until January 1992, some 14 months after poison-baiting, that evidence of fox predation on the trapping grid was found. At that time the half-eaten carcass of an adult Long-nosed Potoroo was found on one of the trap-lines. Two fox scats were found nearby on the same trap-line. During the same period, evidence (odour and tracks) of foxes was found on a

further four trap-lines (Table 1), forcing a premature end to the trapping session.

Over the entire study, evidence of foxes was recorded on eight of 10 trap-lines, with native mammals attacked and/or killed on five trap-lines (Table 1). Evidence of cats, by contrast, was only recorded on four of the 10 trap-lines, although these animals are more cryptic and perhaps more difficult to census than foxes (see data in Triggs *et al.* 1984). It is unlikely that foxes and cats were attracted down trap-lines solely because of the baits I had placed in cage traps. More likely, they responded to the establishment of the trap-lines through habitat disturbance and a number of observations support that notion. For example, fox activity was documented along trap-lines during trapping sessions, irrespective of whether or not the traps along those lines had been baited. As already noted in January 1992, the remains of an adult potoroo, killed by a predator, was found on one of the trap-lines prior to the trapping session for that month and no trapping had been undertaken at that site for over eight weeks. This suggested that a fox had been utilising the trail during my extended absence from the site. Similar observations were made of a single cat, which preyed on antechinus along a trail that had no baited traps for over six weeks.

Foxes and cats were clearly responding to the presence of native ground-dwelling mammals in traps, rather than to the traps *per se*. If the latter were the case, then baited traps would have been disturbed regardless of whether they had captured animals or not. This was not the case since no empty (baited) traps were disturbed by foxes and cats, despite over 5000 trap-nights of effort. Where captured animals were attacked and/or killed by foxes or cats along trap-lines, those animals attacked and/or killed were always the first animals captured along those trap-lines. This suggests that predators moved along trap-lines until a prey item was first encountered.

Native mammals were preyed on in traps placed up to 493 m down trap-lines, as measured from the adjacent main access road (Table 1). Most animals (eight of 12) were killed within 250 m from the main access road. There was no evidence to suggest that foxes had moved into the site via an access route other than down trap-lines. Understorey vegetation throughout the site was extremely thick and sometimes virtually impenetrable from the litter layer to a height of 1–2 m. Tracks left by foxes along the trap-lines indicated movement, in the first instance, into the site from the main access road, rather than out on to the main access road from within the site. Results from the poison-baiting program also confirm that the problem foxes were those which entered the study site from the main access road. Predation on captured native mammals by foxes ceased for a long period (see above) after the baiting program had finished. Thus, if the problem foxes were entering the trapping grid from elsewhere they would not have encountered poison-baits and predation would have continued. In making these conclusions it is important to acknowledge that foxes are known to occupy habitats well away from roads (Phillips and Catling 1991; Catling and Burt 1995), but at a micro-scale (e.g. within catchment), movements may be hampered by extremely dense vegetation. Here, I suggest that foxes were already present in the general vicinity of the Cabbage Tree Creek study site, but took advantage of the localised loss of dense thickets of vegetation to increase the range of their foraging habitat.

Whether cats were behaving in the same way cannot be determined. Recent preliminary hair-tubing surveys in the Central Highlands of Victoria indicate that the detection rate of cats may be higher at sites away from roads than at sites very close to roads (Lindenmayer *et al.* 1994), suggesting that cats prefer to inhabit more contiguous forest habitats. In the present study, the predator control program provided no clues as to the movement patterns of cats into and out of the study site since cats did not consume poison baits.

The present study is limited because it was not designed specifically to see whether introduced predators would exploit opening-up of understorey vegetation at Cabbage Tree Creek. My observations have been made while conducting other ecological studies. In this regard there is an urgent need to explore further the use of tracks and trails by foxes and cats. Despite the anecdotal nature of this study, there are some important implications for wildlife researchers and forest managers. My findings suggest that

field study of native ground-dwelling mammals may be problematic, particularly when those species under investigation require dense vegetation for cover. This is certainly the case for potoroos and bandicoots (Scotts and Seebeck 1989; Claridge *et al.* 1991; Bennett 1993). The opening-up of thickets of vegetation in my study, as a result of establishing trap-lines, apparently led to ingress of foxes into the study site and led to loss of study animals. This observation is corroborated by Claridge *et al.* (1991), who found that foxes utilised trap-lines designed to capture bandicoots. While cats were also found to make use of trap-lines at Cabbage Tree Creek, it is difficult to establish whether they responded to opening-up of the grid in the same way. Nevertheless, the present investigation and that of Claridge *et al.* (1991), adds to the growing body of literature which indicates that some predators will forage in fragmented or recently disturbed habitats (Sievert and Keith 1985; Angelstam 1986; Andren and Angelstam 1988; Yahner 1988).

Some forest management agencies do not consider that predators such as the fox and cat are likely to take advantage of localised increases in the abundance of tracks and trails (e.g. Forestry Commission of New South Wales 1992, p 113; State Forests of New South Wales 1994, p 293). However, the results of the present study indicate that such a view needs to be more rigorously questioned. In forests subject to new roads or timber harvesting (where vegetation cover is reduced) there may be considerable merit in undertaking poison-baiting programs to reduce the impact of introduced predators such as the fox on native ground-dwelling mammals. These poison-baiting programs should be pro-active, rather than reactive (e.g. carried out prior to, during and after habitat disturbance). Poison-baiting campaigns might also be necessary at sites where long-term investigations of the ecology of ground-dwelling mammals are planned. In association with these studies, it may also be worthwhile monitoring the activity of introduced predators along trap-lines, using indirect techniques such as recording tracks in soil plots (Newsome and Catling 1979). Combining these techniques may ensure that the loss of native study animals is minimised.

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Autumn Fungi

In March, a friend from Traralgon South brought me a large leathery Polypore that he had collected from the ground at the butt of a Peppermint Gum. It proved to be *Polyporus hartmanni*. I was in some doubt as to its identity as there were two fruiting bodies, the smaller ones fused with the cap of the larger specimen. *P. hartmanni* is usually solitary. The fungus was very fresh, the velvety caps an attractive reddish brown colour of new saddle leather. The skin is inclined to crack as it dries and reveal the bright mustard yellow colour of the flesh below. The stipe was more or less central, woody and furrowed, the minute pores whitish. This fungus must be collected in very fresh state as boring insects speedily reduce it to honeycomb in the field.

I had the opportunity to visit the site over Easter. There were remnants of four large polypores similar to the first one, each about 15 cm across and each in close proximity to a big tree root. *P. hartmanni* is said to grow from an underground pseudosclerotium, a mass of mycelium matted together with soil and plant debris. Investigation in the very hard ground yielded only tree roots. The situation was on a dry sandy hill slope beneath scattered Messmate/Peppermint timber with an occasional Manna Gum. The soil was hard grazed and riddled with the holes of a species of small black ant, each hole encircled with a neat embankment of sand.

While drying on the back of the stove *P. hartmanni* has a rather disagreeable smell which gives way with time into the delicate aroma of new bread cooking. It is apparently not uncommon in dry seasons, being an annual, and has been sent to me from beyond Bairnsdale and from the hills toward Western Port. Incidentally, among the four mentioned above there was another double-header, proving that this fungus is not always solitary.

I am indebted to Dr May for positive identification.

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The Botany of Howell, New South Wales: A Tin Granite Flora (Revisited)

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Abstract
This paper presents the results of a recent botanical survey of the Howell area. Changes in floristic composition, in comparison with earlier surveys, are considered to result from the absence of fire. (*The Victorian Naturalist*, **115** (3), 1998, 94-99).

In 1905, Joseph Henry Maiden (Government Botanist and Director of the Botanic Gardens, Sydney) and John Luke Boorman (official collector for the Botanic Gardens) visited the mining town of Howell, south west of Inverell in northern New South Wales. Maiden was so taken by his visit to the region that he presented a paper to the Royal Society of New South Wales about the plants found there (Maiden 1906). The paper consisted of a few notes on the most interesting taxa and a list of all plants found, including additional specimens collected on a second trip by Boorman, and those collected by the local public school teacher, Mr. Hart. A number of new taxa were named based on these early collections, and included: *Acacia granitica* Maiden (though not lectotypified, one of two syntypes are from Howell); *Boronia granitica* Maiden & Betche, *Eriostemon myoporoides* subsp. *conduplicatus* P.G.Wilson, and *Eucalyptus caleyi* Maiden. In addition to these, *Homoranthus prolixus* Craven & S.R. Jones has been named from a specimen collected in the Howell area, and *Eucalyptus youmanii* Blakely & McKie was named after the Reverend Youman, amateur botanist of Howell.

Although the paper presented by Maiden is brief, it does allow comparisons to be made with collections that are more recent. The Reverend Youman made occasional collections from the Howell district in the 1930's but it wasn't until John B. Williams (lecturer of the Botany Department of the University of New England, since retired) and Hans Wissman went to the area in the late 1960's that any further intense collecting was undertaken (Williams and Wissman 1969). This was followed up by visits in the early 1980's by a naturalist National Parks Ranger, Greg Roberts, who later produced a thesis on the granitic areas of the New England Batholith (Roberts 1983). The most recent collections have come from an extensive systematic survey of the granitic outcrop vegetation of the New England Batholith, conducted in 1995 by myself. The batholith encompasses parts of north-east New South Wales and south-eastern Queensland, extending for approximately 400 km in length and 110 km in width, from Stanthorpe in Queensland to Tamworth in New South Wales (Leigh 1968). My present survey of Howell was based on the placement of 45 full floristic 0.1 ha sites which were placed within a 5 km radius of Howell, ninety years after Maiden's visit to the area.

Now, very little is left of the town apart from old bottles and cracked china plates, and the occasional impression of the floor plan of a house. Mining waned from the 1930s onward but continued somewhat for silver, tin and diamonds until the late 1960s and mining options are kept open even now. A few kilometres to the west of the town are the shores of the large Copeton Dam.

Maiden restricted his comments to a region two to three miles around Howell, which he describes as being dominated over a large area by *Acacia*, particularly *Acacia neriifolia* A. Cunn. ex Benth. This species is still probably the most abundant *Acacia* in the area. However, wattles certainly do not dominate such a large area and, in the main, are restricted to recently disturbed areas and rock outcrops. Maiden considered a number of species to be abundant or, at least, not rare in the area and these included the Ironbark eucalypts (of secondary growth), *Phebalium rotundifolium* (Cunn. ex Endl.) Benth., *Mirbelia speciosa* Sieber ex DC and *Actinotus helianthi* Labill. Other interesting collections included *Monotaxis macrophylla*

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Benth., *Muehlenbeckia rhyticarya* F. Muell. ex Benth. and *Macrozamia heteromera* C. Moore. Since Maiden's visit in 1905 such observations cannot be made. In contrast, the ironbark eucalypts and most other eucalypts do not appear to be as abundant or large as Maiden suggested while the species *Phebalium rotundifolium*, *Mirbelia speciosa* and *Actinotus helianthi* are very rare in the area. Also, since Maiden's time *Monotaxis macrophylla* and *Muehlenbeckia rhyticarya* have not been found in the area and I was unable to find any *Macrozamia heteromera* in my visits to the area around the township. One of the most interesting observations made by Maiden was that *Callitris* was rare, yet today, *Callitris* is so abundant that it often forms monospecific stands and is the dominant plant in the entire district. Land managers within the area consider *Callitris* a problem and have sought the assistance of the Soil Conservation services for strategies to combat its dominance.

It appears that in the ninety years since Maidens visit, a substantial change has occurred in the vegetation of the Howell area. The inescapable conclusion from perusing the species lists is that an absence of fire has caused these major changes. Maiden's list includes many species that are fire-ephemeral or fire-promoted. *Monotaxis macrophylla* is a fire-promoted species (Hunter and Bruhl 1997; Hunter 1998) and currently considered endangered in New South Wales (TSC act New South Wales Government 1995). From personal observations, I have found the germination of *Muehlenbeckia rhyticarya*, *Phebalium rotundifolium, Daviesia latifolia* R. Br., and *Actinotus helianthi* is promoted by fire, but fire is known to kill *Callitris* outright and reduce its dominance in an area. In the last 60 years no major fires have occurred in the vicinity of Howell. *Callitris* is an aggressive coloniser of new sites in the absence of severe wildfires or grazing (Forestry Commission of New South Wales 1988; Young and McDonald 1989). Although seeds have brief longevity the species is a prolific seeder and will regenerate thickly but lacks a self-thinning strategy (Forestry Commission of New South Wales 1988). In the absence of fire, *Callitris* can become mono-dominant and exclude most other species. The observations made at Howell fit well with Gill (1981) who describes a replacement series in *Callitris–Eucalyptus* woodlands. The simplest scenario describes *Eucalyptus* species as being resprouters that will regenerate from seed only after fire. *Callitris* is killed by fire yet the canopy-stored seed will be released and can germinate any time in the inter-fire period. *Callitris* seedlings, however, take ten years to become reproductively mature. Without fire *Callitris* will dominate, as it will continue to recruit while the *Eucalyptus* species will eventually die out in about 100 years.

This comparison shows the importance of communicating even minor observations of flora and fauna in a permanent manner such as a short note in a naturalists' magazine or journal. What might be considered of little importance now might be of interest years from now and it is also important to revisit sites where old observations have been made. They may give us a clue to the problems we may be facing now, for instance, the dominance of *Callitris* and the disappearance of endangered species (e.g. *Monotaxis macrophylla*).

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Appendix
Checklist of plants found at Howell

Plant taxa previously observed but not seen by the author are indicated as follows: @ seen by Maiden (1905); # seen by Williams and Wissman (1969); * introduced species. Most collections have been made in relatively undisturbed habitat therefore introduced species numbers are lower than what may be in the general area. Names have been updated where possible. Common names given are those in use in N.S.W.

Ferns

Adiantaceae
#*Adiantum hispidulum* Sw. (Rough Maidenhair)

Aspleniaceae
#*Pleurosorus rutifolius* (R.Br.) Feé (Blanket Fern)
Pleurosorus subglandulosus (Hook. & Grev.) Tindale (Blanket Fern)

Blechnaceae
Blechnum cartilagineum Sw. (Gristle Fern)

Cyatheaceae
Cyathea australis (R.Br.) Domin (Tree Fern)

Dennstaedtiaceae
#*Pteridium esculentum* (G.Forst.) Cockayne (Bracken Fern)

Sinopteridaceae
Cheilanthes distans (R.Br.) Mett. (Hairy Rock Fern)
Cheilanthes sieberi Kunze subsp. *sieberi* (Narrow Rock Fern)

Gymnosperms and Cycads

Cupressaceae
Callitris endlicheri (Parl.) F.M.Bailey (Black Cypress Pine)
Callitris glaucophylla Joy Thomps. & L.A.S.Johnson (White Cypress Pine)

Cycadaceae
@*Macrozamia heteromera* C.Moore (Burrawang)

Monocotyledons

Anthericaceae
Arthropodium milleflorum (DC.) J.F.Macbr. (Pale Vanilla Lily)
Caesia calliantha R.J.F.Hend. (Grass Lily)
Dichopogon fimbriatus (R.Br.) J.F.Macbr. (Nodding Chocolate Lily)
Laxmannia compacta Conran & P.I.Forst. (Wire Lily)
Laxmannia gracilis R.Br. (Wire Lily)
Tricoryne elatior R.Br. (Yellow Rush Lily)

Asphodelaceae
@*Bulbine bulbosa* (R.Br.) Haw. (Golden Lily)

Centrolepidaceae
Centrolepis strigosa (R.Br.) Roem. & Schult. (Hairy Centrolepis)

Commelinaceae
Commelina cyanea R.Br. (Scurvy Weed)
Murdannia graminea (R.Br.) Bròckn.

Cyperaceae
Bulbostylis pyriformis S.T.Blake (Small Sedge)
@*Cyperus dactylotes* Benth. (Sedge)
Cyperus fulvus R.Br. (Sticky Sedge)
Cyperus gracilis R.Br. (Small Sedge)
Fimbristylis dichotoma (L.) Vahl (Common Fringe Rush)
Gahnia aspera (R.Br.) Spreng. (Rough Saw Sedge)
@*Gahnia filifolia* (C.Presl) Kòk. ex Benl (Saw Sedge)
Lepidosperma laterale R.Br. (Variable Sword Sedge)

Haemodoraceae
@*Haemodorum planifolium* R.Br. (Bloodroot)

Iridaceae
Patersonia sericea R.Br. (Blue Flag)

Juncaceae
#*Juncus pauciflorus* R.Br. (Rush)
Juncus remotiflorus L.A.S.Johnson (Rush)

Lomandraceae
Lomandra filiformis (Thunb.) Britten (Wattle Mat Rush)
Lomandra longifolia Labill. (Spiny Headed Mat Rush)
Lomandra multiflora (R.Br.) Britten (Many Flowered Mat Rush)

Orchidaceae
Calochilus robertsonii Benth. (Purple Beard Orchid)
Cymbidium canaliculatum R.Br. (Black Orchid)
Prasophyllum campestre R.J.Bates & D.L.Jones (Leek Orchid)
Pterostylis setifera M.A.Clem. Matthias & D.L.Jones (Greenhood)
Pterostylis woollsii Fitzg. (Greenhood)

Phormiaceae
Dianella caerulea Sims (Flax Lily)
Dianella longifolia R.Br. (Flax Lily)
Stypandra glauca R.Br. (Nodding Blue Lily)
Thelionema caespitosum (R.Br.) R.J.F. Hend.
Thelionema grande (C.T.White) R.J.F.Hend.

Philydraceae
@*Philydrum lanuginosum* Bks. (Frogsmouth)

Poaceae
Aristida jerichoensis (Domin) Domin ex. Henrard (Wiregrass)
Aristida vagans Cav. (Three-awned Speargrass)
Arundinella nepalensis Trin. (Reedgrass)
Ausrodanthonia linkii (Kunth) H.P.Linder (Wallaby Grass)
Austrostipa bigeniculata (Hughes) S.W.L.Jacobs & J.Everett (Yanganbil)
Austrostipa tuckeri (F.Muell.) S.W.L.Jacobs & J.Everett (Tucker's Speargrass)
#*Austrostipa verticillata* (Nees ex. Spreng.) S.W.L.Jacobs & J.Everett (Slender Bamboo Grass)
**Bromus cartharticus* Vahl. (Prairie Grass)
Cleistochloa rigida (S.T.Blake) R.D.Webster
Cymbopogon refractus (R.Br.) A.Camus (Barbed-wire Grass)
Cynodon dactylon (L.) Pers. (Couch Grass)
#*Dichelachne sciurea* Hook.f. (Plume Grass)
Digitaria breviglumis (Domin) Henrard (Umbrella Grass)
Digitaria hystrichoides Vickery (Curly Umbrella Grass)

*#*Digitaria sanguinalis* (L.) Scop. (Summer Lovegrass)
Echinopogon caespitosus C.E.Hubb. subsp. *caespitosus* (Hedgehog Grass)
Echinopogon cheelii C.E.Hubb. (Long-flowered Hedgehog Grass)
Echinopogon ovatus (G.Forst.) P.Beauv. (Forest Hedgehog Grass)
Entolasia stricta (R.Br.) Hughes (Rice-flowered Grass)
Eragrostis brownii (Kunth) Nees (Brown's Lovegrass)
*#*Eragrostis pilosa* (L) P.Beauv. (Soft Lovegrass)
#*Eulalia aurea* (Bory) Kunth (Silky Browntop)
*#*Holcus lanatus* L. (Yorkshire Fog)
Imperata cylindrica P.Beauv. (Blady Grass)
Microlaena stipoides (Labill.) R.Br. var. *stipoides* (Meadow Rice Grass)
**Panicum antidotale* Retz. (Giant Panic)
Paspalidium constrictum (Domin) C.E.Hubb. (Box Grass)
Poa sieberiana Spreng. (Fine-leafed Tussock Grass)
**Setaria pumila* (Poir.) Roem. & Schult. (Pale Pidgeon Grass)
**Setaria verticillata* (L.) P.Beauv. (Whorled Pidgeon Grass)
Themeda triandra Forsskal (Kangaroo Grass)
Tripogon loliiformis (F.Muell.) C.E.Hubb. (Five-minute Grass)

Restionaceae
Lepyrodia leptocaulis L.A.S.Johnson & O.D.Evans

Xanthorrhoeaceae
Xanthorrhoea acaulis (A.T.Lee) D.J.Bedford (Grass Tree)

Dicotyledons

Apiaceae
Actinotus gibbonsii F.Muell. (Gibbons Flannel Flower)
Actinotus helianthi Labill. (Giant Flannel Flower)
Hydrocotyle peduncularis R.Br. ex A.Rich. (Wild Parsley)
Trachymene incisa Rudge (Native Parsnip)

Apocynaceae
Parsonsia eucalyptophylla F.Muell. (Gargaloo)

Asteraceae
**Bidens pilosa* L. (Cobbler's Peg)
Brachyscome dissectifolia G.L.R.Davis
Brachyscome multifida DC. var. *multifida* (Cut Leaf Daisy)
Brachyscome stuartii Benth. (Granite Daisy)
@*Bracteantha bracteata* (Vent.) Anderb. & Haegi (Golden Everlasting)
Calotis hispidula (F.Muell.) F.Muell. (Bogan Flea)
Cassinia laevis R.Br. (Cough Bush)
Cassinia quinquefaria R.Br. (Cassinia)
Cassinia uncata A.Cunn. ex DC. (Sticky Cassinia)
Chrysocephalum apiculatum (Labill.) Steetz. (Yellow Buttons)
Chrysocephalum semipappo sum (Labill.) Steetz. (Yellow Buttons)
@*Cotula australis* (Sieber ex Spreng.) Hook.f. (Common Cotula)
Euchiton sphaericum (Willd.) Holub (Japanese Cudweed)
**Hypochaeris radicata* L. (Catsear)
#*Olearia ramosissima* (DC.) Benth. (Daisy Bush)
#*Olearia ramulosa* (Labill.) Benth. (Twiggy Daisy Bush)
Olearia viscidula (F.Muell.) Benth. (Sticky Olearia)
Ozothamnus obcordatus DC. (Daisy Bush)
Podolepis neglecta G.L.R.Davis (Showy Copper-wire Daisy)
Senecio lautus G.Forst. ex Willd. (Variable Groundsell)
Senecio quadridentatus Labill. (Common Fireweed)
Sigesbeckia australiensis D.L.Schulz. (Pale Indian Weed)
Solenogyne bellioides Cass. (Solenogyne)
Vittadinia dissecta (Benth.) N.T.Burb. (Fuzzweed)
Vittadinia sulcata N.T.Burb. (Fuzzweed)

Brassicaceae
Lepidium pseudohyssopifoli um Hewson (Peppercress)

Cactaceae
**Opuntia aurantiaca* Lindl. (Tiger Pear)
**Opuntia stricta* (Haw.) Haw. (Prickly Pear)

Campanulaceae
Wahlenbergia communis Carolin (Austral Bluebell)

Caryophyllaceae
**Petrorhagia nanteuilii* (Burnat) P.W.Ball & Heywood (Proliferous Pink)

Chenopodiaceae
Chenopodium pumilio R.Br. (Small Crumbweed)
Einadia hastata (R.Br.) A.J.Scott (Saloop)

Clusiaceae
Hypericum gramineum G.Forst. (Small St. Johns Wort)

Convolvulaceae
Dichondra sp. A (Kidney Weed)
Evolvulus alsinoides (L.) L. var. *decumbens* (R.Br.) Ooststr.

Crassulaceae
Crassula sieberiana (Schult. & Schult.f.) Druce (Stonecrop)

Cucurbitaceae
**Citrullus lanatus* (Thunb.) Matsum. & Nakai (Bitter Melon)

Dilleniaceae
Hibbertia acicularis (Labill.) F.Muell. (Prickly Guinea-flower)
Hibbertia kaputarensis B.J.Conn (Guinea-flower)
@*Hibbertia linearis* R.Br. ex DC. (Guinea-flower)
@*Hibbertia pedunculata* R.Br. ex DC. (Guinea-flower)
Hibbertia riparia (R.Br. ex DC.) Hoogland (Erect Guinea-flower)
#*Hibbertia vestita* A.Cunn. ex Benth. (Hairy Guinea-flower)

Droseraceae
#*Drosera burmannii* Vahl. (Sundew)
Drosera peltata Thunb. (Pale Sundew)

Epacridaceae
Brachyloma daphnoides (Sm.) Benth. subsp. *glabrum* (Blakely) J.T.Hunter
Leucopogon lanceolatus (Sm.) R.Br. (Beard Heath)
Leucopogon melaleucoides Cunn. ex DC. (Beard Heath)

Leucopogon muticus R.Br. (Beard Heath)
Leucopogon neoanglicus F.Muell. ex Benth. (New England Beard Heath)
Lissanthe strigosa (Sm.) R.Br. (Peach Heath)
Melichrus urceolatus R.Br. (Urn Heath)
Monotoca scoparia (Sm.) R.Br.

Euphorbiaceae
#*Beyeria viscosa* (Labill.) Miq. (Sticky Wallaby Bush)
@*Monotaxis macrophylla* Benth.
@*Phyllanthus occidentalis* J.T.Hunter & J.J.Bruhl (Thyme Spurge)
#*Phyllanthus subcrenulatus* F.Muell. (Creek Spurge)
#*Phyllanthus virgatus* G.Forst. (Twiggy Spurge)
Poranthera microphylla Brongn. (Small Poranthera)

Mimosaceae
Acacia brownii (Poiret) Steudel
@*Acacia decora* Reichb. (Western Golden Wattle)
@*Acacia wilhelmiaca* F.Muell. (Wilhelmiana Wattle)
Acacia falciformis DC. (Broad-leaved Hickory)
Acacia granitica Maiden (Granite Wattle)
@*Acacia implexa* Benth. (Hickory Wattle)
Acacia lanigera A.Cunn. (Hairy Wattle)
Acacia leptoclada A.Cunn. ex Benth.
@*Acacia linifolia* Willd. (Flax-leaved Wattle)
Acacia neriifolia A.Cunn. ex Benth. (Oleander Wattle)
Acacia penninervis Sieber ex DC. (Mountain Hickory)
@#*Acacia spectabilis* A.Cunn. ex Benth. (Mudgee Wattle)
Acacia triptera Benth. (Spurwing Wattle)
Acacia ulicifolia (Salisb.) Court. (Prickly Moses)
Acacia viscidula Benth. (Granite Sticky Wattle)

Fabaceae
@*Bossiaea buxifolia* A.Cunn. (Matted Bossiaea)
Bossiaea heterophylla Vent.
Bossiaea obcordata (Vent.) Druce
@*Daviesia latifolia* R.Br.(Large-leafed Bitter Pea)
@*Daviesia pubigera* A.Cunn. ex Benth. (Bitter Pea)
Desmodium brachypodum A.Gray (Large Tick-treefoil)
@*Dillwynia floribunda* Sm. (Egg and Bacon)
Dillwynia sieberi Steud. (Egg and Bacon)
Dillwynia phylicoides A.Cunn. (Egg and Bacon)
Glycine clandestina J.C.Wendl. (Twining Glycine)
@#*Gompholobium hugelii* Benth. (Pale Wedge Pea)
Hardenbergia violacea (Schneev.) Stearn (False Sarsparilla)
Hovea lanceolata J.Sims
Hovea linearis (Sm.) R.Br.*
Indigofera australis Willd. (Hill Indigo)
@*Jacksonia scoparia* R.Br. ex Sm. (Dogwood)
Mirbelia pungens A.Cunn. ex G.Don (Prickly Bush Pea)
@#*Mirbelia speciosa* Sieber ex DC.
Pultenaea sp. C (Egg and Bacon)
@*Pultenaea villosa* Willd. (Egg and Bacon)
@*Swainsona galegifolia* (Andrews) R.Br. (Smooth Darling Pea)
Trifolium arvense L. (Haresfoot Clover)

Gentianaceae
*#*Centaurium erythraea* Rafn (Common Century)

Goodeniaceae
#*Dampiera purpurea* R.Br.
Goodenia bellidifolia Sm. subsp. *argentea* Carolin
#*Goodenia gracilis* R.Br. (Slender Goodenia)
Goodenia hederacea Sm. subsp. *hederacea* (Forest Goodenia)
@*Goodenia delicata* Carolin

Haloragaceae
Gonocarpus micranthus Thunb. (Raspwort)
Gonocarpus tetragynus Labill. (Raspwort)
Gonocarpus teucrioides DC. (Raspwort)

Lamiaceae
Plectranthus parviflorus Willd. (Cockspur-flower)
#*Prostanthera euphrasioides* Benth. (Mintbush)
@*Prostanthera granitica* Maiden & Betche (Granite Mintbush)
Prostanthera nivea A.Cunn. ex Benth. (Showy Mintbush)
Westringia eremicola A.Cunn. ex Benth. (Slender Western Rosemary)

Lobeliaceae
Isotoma anethifolia (Summerh.) F.Wimmer (Isotome)
Isotoma axillaris Lindl. (Showy Isotome)
Lobelia gracilis Andrews (Lobelia)

Loranthaceae
Amyema pendulum (Sieber ex Spreng.) Tiegh. (Mistletoe)
Muellerina celastroides (Sieber ex Schult. & Schult.f.) Tiegh. (Mistletoe)

Moraceae
Ficus rubiginosa Desf. ex Vent. (Fig)

Myrtaceae
Angophora floribunda (Sm.) Sweet (Rough-barked Apple)
Babingtonia densifolia (Sm.) F.Muell.
#*Callistemon linearis* (Schrader & Wendl.) Sweet (Narrow-leaved Bottlebrush)
Callistemon pungens Lumley & R.D.Spencer (Bottlebrush)
Calytrix tetragona Labill. (Common Fringe Myrtle)
Eucalyptus andrewsii Maiden (New England Blackbutt)
Eucalyptus banksii Maiden (Tenterfield Woollybut)
Eucalyptus bridgesiana R.T.Baker (Apple Box)
Eucalyptus caleyi Maiden subsp. *caleyi* (Caley's Ironbark)
Eucalyptus dealbata A.Cunn. ex Schauer (Tumble Down Gum)
Eucalyptus macrorhyncha F.Muell. ex Benth. (Red Stringybark)
Eucalyptus nova-anglica H.Deane & Maiden (New England Peppermint)
Eucalyptus prava L.A.S.Johnson & K.D.Hill (Orange Gum)
Eucalyptus sideroxylon A.Cunn. ex Woolls (Mugga Ironbark)

Eucalyptus youmanii Blakely & McKie (Youman's Stringybark)
Homoranthus prolixus Craven & S.R.Jones (Honey Myrtle)
Kunzea parvifolia Schauer (Violet Kunzea)
@#*Kunzea opposita* F.Muell.
Leptospermum arachnoides Gaertner (Tea Tree)
Leptospermum brachyandrum (F.Muell.) Druce (Tea-tree)
Leptospermum brevipes F.Muell. (Granite Tea-tree)
@*Leptospermum trinervium* (Sm.) Joy Thomps. (Tea-tree)
@*Leptospermum polygalifolium* Salisb. (Tea-tree)
Leptospermum novae-angliae Joy Thomps. (Tea-tree)
@*Leptospermum scoparium* J.R.Forst. & G.Forst. (Tea-tree)
Micromyrtus sessilis J.W.Green

Olacaceae
@*Olax stricta* R.Br.

Oleaceae
Notelaea microcarpa R.Br. var. *microcarpa* (Mock Olive)

Oxalidaceae
Oxalis chnoodes Lourteig (Wood Sorrel)
Oxalis radicosa A.Rich. (Wood Sorrel)

Phytolaccaceae
**Phytolacca octandra* L. (Red Ink Weed)

Pittosporaceae
@*Bursaria spinosa* Cav. (Native Blackthorn)
#*Cheiranthera cyanea* Brongn. var. *cyanea* (Finger Flower)

Plantaginaceae
Plantago debilis R.Br. (Shade Plantain)
**Plantago lanceolata* L. (Ribwort)

Polygalaceae
@*Comesperma ericinum* DC. (Milkwort)

Polygonaceae
@*Muehlenbeckia rhyticarya* F.Muell. ex Benth. (Lignum)

Portulaccaceae
Calandrinia eremaea Ewart (Small Purslane)
Portulaca bicolor F.Muell. var. *rosea* Maiden & Betche (Portulaca)
Portulaca filifolia F.Muell. (Slender Pigweed)
Portulaca oleracea L. (Common Pigweed)

Proteaceae
@*Grevillea floribunda* R.Br. (Rusty Spider Flower)
Grevillea ramosissima Meissn. (Spider Flower)
@*Hakea microcarpa* R.Br. (Small-fruited Hakea)
#*Isopogon petiolaris* A.Cunn. ex R.Br. (Drumstick)
#*Lomatia silaifolia* (Sm.) R.Br. (Crinkle Bush)
Persoonia cornifolia A.Cunn. ex R.Br. (Common Geebung)
#*Petrophile canescens* A.Cunn. ex R.Br. (Conestick)

Ranunculaceae
#*Clematis glycinoides* DC. (Headache Vine)
@*Ranunculus lappaceus* Sm. (Common Buttercup)
Ranunculus sessiliflorus R.Br. ex DC. var. *sessiliflorus* (Small-flowered Buttercup)

Rhamnaceae
Alphitona excelsa (Fenzl) Benth.
Cryptandra amara Sm. subsp. *longiflora* F.Muell. ex Maiden & Betche

Rubiaceae
Opercularia aspera Gaertn. (Stinkweed)
Galium gaudichaudii DC. (Bedstraw)
Opercularia hispida Spreng. (Hairy Stinkweed)
Pomax umbellata (Gaertn.) Benth. (Pomax)

Rutaceae
#*Boronia anethifolia* A.Cunn. (White and Red Boronia)
Boronia granitica Maiden & Betche (Granite Boronia)
Correa reflexa (Labill.) Vent. (Common Correa)
Crowea exalata F.Muell.
Eriostemon myoporoides DC. subsp. *conduplicatus* P.G.Wilson (Waxflower)
Phebalium rotundifolium (Cunn. ex Endl.) Benth.
Zieria cytisoides Sm. (Downy Zieria)
Zieria odorifera m.s. Armstrong (Stinking Zieria)
@*Zieria pilosa* Rudge

Santalaceae
@*Choretrum candollei* F.Muell. ex Benth. (Sour Bush)
Exocarpus cupressiformis Labill. (Native Cherry)

Sapindaceae
@*Dodonaea viscosa* subsp. *attenuata* (DC.) J.West (Narrow-leaf Hopbush)
@*Dodonaea viscosa* subsp. *cuneata* (Sm.) J.West (Wedge Leaf Hopbush)
Dodonaea stenophylla F.Muell. (Narrow-leaf Hopbush)

Scrophulariaceae
@*Derwentia derwentiana* (Andrews) B.G.Briggs & Ehrand. (Speedwell)

Simaroubaceae
**Ailanthus altissima* (Mill.) Swingle (Tree of Heaven)

Solanaceae
@#*Solanum cinereum* R.Br. (Nightshade)
Solanum opacum A.Braum. & Bouch. (Nightshade)
@*Solanum parvifolium* R.Br. (Nightshade)

Stackhousiaceae
@*Stackhousia monogyna* Labill.
Stackhousia viminea Sm. (Slender Stackhousia)

Sterculiaceae
@*Rulingia dasyphylla* (Andrews) Sw. (Kerrawang)

Stylidiaceae
@*Stylidium graminifolium* Sw. ex Willd. (Stylewort)

Thymeliaceae
@*Pimelea linifolia* Sm. (Rice Flower)

Urticaceae
Urtica incisa Poir. (Stinging Nettle)

Viscaceae
Notothixos subaureus Oliv. (Golden Mistletoe)

Intertidal Sighting and Behaviour of *Octopus maorum* Hutton 1880

Platon Vafiadis[1]

Abstract
In March 1997 a large Maori Octopus *Octopus maorum* Hutton 1880 was seen intertidally at Smith's Beach, Phillip Island. This article describes the animal and its behaviour, and provides a brief overview of the species. (*The Victorian Naturalist*, **115 (3)**, 1998, 100-104).

Introduction

A recent encounter with an active Maori Octopus *Octopus maorum* Hutton 1880 in the intertidal zone provides the opportunity to report on the foraging behaviour of this species. The octopus was seen in an intertidal rock pool at Smith's Beach, Phillip Island, shortly after 9:00 am on Tuesday 11 March, 1997. The day was cool but sunny, and the tide had started to rise.

The animal was first observed semi-submerged and wedged in a triangular space between two boulders, apparently inactive. Our disturbance of the water seemed to stimulate it, causing the octopus to emerge quickly. It immediately began to hunt, an activity which we were able to observe from the edge of the pool for the next hour.

Morphology and biogeography of *Octopus maorum*

Although the octopus had packed itself into a relatively small crevice, it was in fact a large creature. Size was gauged on the basis of photographs, by comparing the animal to the gastropod shells *Austrocochlea constricta* Lamarck 1822 that were also present. Mantle length was estimated to be between 25–35 cm, and total length at 1.0–1.3 m. *Octopus maorum* is the only octopus in Victorian waters which attains this size, and is the largest found in south-eastern Australian waters (Stranks 1988). It reaches a total length of up to 1.2 m and a weight of 9 kg (Edgar 1997). Formerly known as *O. flindersi* Cotton 1932, it was subsequently found to be identical to the New Zealand species *O. maorum* that Hutton had described in 1880. Stranks (1988) provides details of the anatomical characteristics and distribution of this species.

The dorsal surface of the Smith's Beach Octopus was orange to reddish-brown in colour, and the ventral surfaces pale orange, consistent with descriptions of *O. maorum* (Edgar 1997). Its fleshy web would lighten in colour with certain movements. Stranks (1988) notes that at rest *O. maorum* is, dorsally, often a grey or brown colour becoming a darker red or brown when stimulated. Paler spots scattered over the dorsal arm, crown and web (most evident in Fig. 1) are also characteristic (Stranks 1997 *pers. comm.*). Additionally, the presence of a distinct constriction between the head and mantle is said to be a feature of the species (Stranks 1988; Zeidler and Norris 1989; Edgar 1997).

The octopus had long arms (the dorsal arms longest) that tapered away to fine, probing tips. Large suckers (about 1 cm across) from the proximal and middle parts of the arms gripped rocks. Stranks (1988) notes that *O. maorum* has biserial suckers (as demonstrated in the distal arms by Fig. 2). The third right arm, shown in Fig. 3, appeared long and unmodified, suggesting that the octopus was a female, since male octopuses have a modified (or hectocotylised) third right arm that enables spermatophore transfer to the female (see Hanlon and Messenger 1996). A detailed description of the hectocotylus of *O. maorum* is found in Stranks (1988).

At times the octopus in the rock pool raised up erectile papillae on its mantle, disrupting its smooth contour. Its eyes were large and raised. The funnel, about 2 cm wide, was clearly visible (Fig. 2 and Fig. 4), as was the opening to the mantle cavity (Fig. 4), which gaped rhythmically as the octopus respired.

Octopus maorum belongs to the *O. macropus* species group Robson 1929, which consists of medium sized to large

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octopuses (Norman and Sweeney 1997). The typical features of this group are that the dorsal arms are longer and more powerful than the ventral arms, the web is deepest dorsally, they have many lamellae on their gills (10-15), and possess a distinctive radula in which the central tooth bears several cusps (Norman and Sweeney 1997).

Octopus maorum is found only in south-eastern Australia (from the central Great Australian Bight to central NSW, and around Tasmania) and New Zealand (in both North and South Islands, and several small offshore island groups) (Stranks 1988; Stranks 1996). Of the seven shallow water species of benthic *Octopus* known in

Fig. 1. The octopus crawling forwards.

Fig. 2. The octopus propelling itself forwards through the water.

south-eastern Australia, only *O. maorum* Hutton 1880 and *O. warringa* Stranks 1990 are also found in New Zealand. This is possibly because they lay large numbers of relatively small eggs which likely produce planktonic hatchlings that remain in the water column for some time before settling to the bottom (Stranks 1988; Stranks 1996). This, together with their high number, increases the chances of dispersal from Australia to New Zealand by the eastward flowing current systems (Stranks 1996). It is believed that the adults themselves do not migrate over extended ranges, making planktonic dispersal the favoured theory (Stranks 1996). The duration of the planktonic phase of *O. maorum* is unknown, but may be as long as three months (Stranks 1996).

Description of behaviour

At Smith's Beach, first action of the octopus after emerging from the crevice was to pounce on the side of a large rock, with the web forming a kind of net (Fig. 3; for description of this behaviour see also Hanlon and Messenger 1996). The long arms stretched to both sides of the rock and prised into minute cracks and corners, flushing out a number of small fish and shrimps. One fish about 5 cm long was seen to be held fast by the fine, distal tip of a dorsal arm and quickly conveyed to the mouth.

The octopus moved quickly and hunted up and down the length of the large rock pool, which was about 7 m long and, on average, about 2 m wide. The pool varied in depth and the octopus was partly out of the water when traversing some shallow areas. At times it would pounce with its web expanded, splaying itself on either side of a rock and probing every crack. At other times it would splay out against narrow ledges, head centrally and arms fully extended in a straight line on either side. It also swam, sometimes by propelling itself forward with the arms leading (Fig. 2), and sometimes mantle first with all arms streaming behind. Crawling was also observed (Fig. 1).

Several instances of digging behaviour were also seen. At one point the octopus approached a large, flat rock in the middle of the pool and started to excavate beneath it. With considerable power, not only rocky gravel, but a 4 cm live dog-winkle *Thais orbita* (Gmelin 1791) and stones the size of a small fist were thrust out behind the digging octopus. It soon managed to wedge most of its body beneath the rock, where it remained active for a few minutes.

No ink was released during our very

Fig. 3. The octopus pouncing on a large rock. It splayed its fleshy umbrella on the side of the rock and spread out its arms, searching for prey.

rewarding, hour-long observations.

Octopuses belonging to the *O. macropus* species group Robson 1929, of which *O. maorum* is one, are typically nocturnally active, feeding on fish, crustaceans, bivalves and even other octopuses (Norman 1992; Norman and Sweeney 1997). *Octopus maorum,* however, is exceptional in that it often hunts during the day (Norman 1997, *pers. comm.*), which explains this current sighting. It is known to have a preference for rocky reefs (Stranks 1988), and is restricted to the continental shelf and upper continental slope, from the intertidal zone to depths of about 500 m (Stranks 1988).

Other behavioural references to this octopus mention its feeding and reproductive habits. *Octopus maorum* is an active hunter of lobster and is frequently brought up in lobster pots (Edgar 1997; Zeidler and Norris 1989). Hand (1975) noted that commensal relationships between the anemone *Calliactis conchicola* Parry 1952 and the Spider Crab *Leptomithrax longipes* protected the crab from predation by *O. maorum* in captivity. Batham (1957) described egg laying and brooding in captivity, noting that a mature female *O. maorum* laid a sheet of 7,000 eggs which hatched in eighty days. The eggs are relatively small, 6–7 mm long, and attached to the substrate singly via a stalk (Stranks 1988). The firm attachment to the substratum facilitates the breaking open of the egg capsule by the hatchling, which emerges at a total length of about 7 mm (Batham 1957). Larger planktonic hatchlings with mantle lengths of 13–17 mm have also been recorded from eastern Tasmania (Stranks 1996).

The lifespan of most cephalopods is limited to one or two years (Boyle 1987), although very large or very cold-water species sometimes live a few years longer, and *Nautilus* might live up to 15 years (Hanlon and Messenger 1996). Therefore, *O. maorum*, like most other cephalopods, probably grows rapidly, 'live(s) fast and die(s) young' (Hanlon and Messenger 1996).

Acknowledgement

The author is indebted to Dr. Mark Norman of the Zoology Department at The University of Melbourne and to Mr. Timothy Stranks of the Department of Invertebrate Zoology at the Museum of Victoria for their support and assistance in identifying the octopus and in providing useful reference material. They also reviewed earlier drafts of this manuscript and made valuable suggestions which have greatly improved it. Thanks are also extended to Robyn Mary Vafiadis, with whom the author spotted the octopus, and to the anonymous reviewers of this article for their support and guidance.

Fig. 4. The octopus gripping a large rock with several arms, searching for food.

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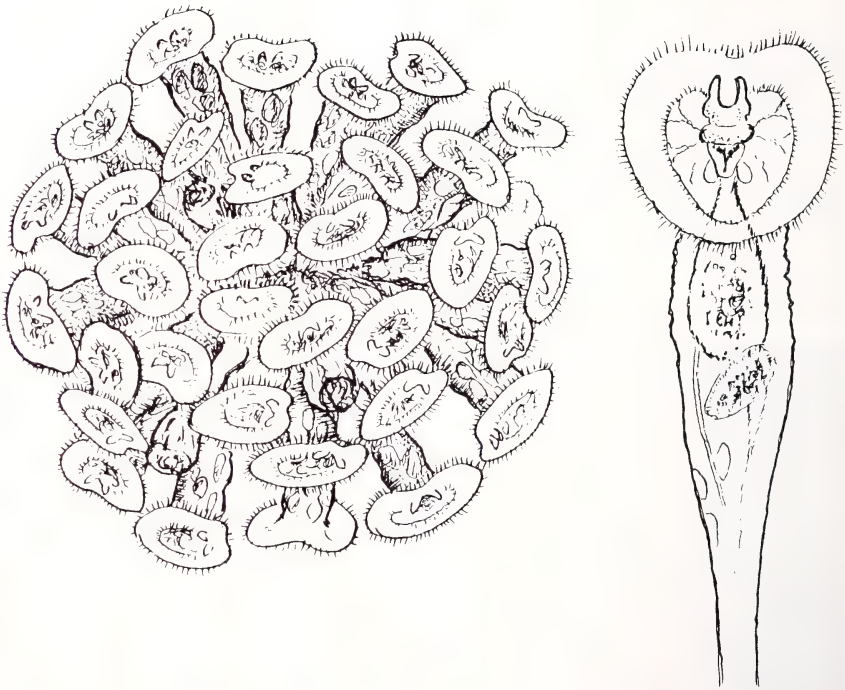
A Colony of *Lacinularia* sp.



Lacinularia sp. are colony building rotifers, either attached to vegetation or free drifting, and can be found in reservoirs and billabongs. The shape and size of colonies can aid identification. The colony, illustrated above, was found in Glynns Reserve, Warrandyte (29/09/97). It was free floating and globular, visible to the naked eye drifting very slowly and gently through the water, like tiny floss balls. The average size of colonies was 2–3 mm; a single colony can have up to 250 individuals depending on the species. For us, it was a unique find since we have not found them again in any of the many waters we regularly check.

Erich Sacco.
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From our Naturalist in the Country

A Man with a Many Track Mind

When I slip into reverie mode (which is pretty often these days) I sometimes find myself bumping along one of the innumerable country roads and tracks I followed many years ago in my job of identifying geological formations and phenomena. I visited many parts of the State, and became very familiar with some areas. Vehicles, fuel, field assistant and generous expense allowance were provided to facilitate this resource evaluation, and observations of other aspects of nature study followed as a matter of course.

So, thirty years afterwards I conjure up the stringybark logs crisscrossing over long unused logging access roads off the WB Line, necessitating laborious chainsaw work, but allowing us access into the beauties of the Genoa River catchment.

Fifty kilometres to the west, over by Bendoc, I have a very clear picture of the track winding around great gums. Our horror on investigating a pestilent odour at lunch time, and finding a decayed stump crammed with lyre-bird, wombat, wallaby and possum carcasses, the spoils of the dingo trappers. After finding three more such caches our retribution was swift, for we flung far away into the bush the dog traps we found at each site.

Ten years before that, I am north of Tyers on the recently dozed track down to the still-to-be-installed Rintouls Creek ford, and its nearby Cretaceous fossil plant localities, and battling (on foot) upstream through silent treefern glades on the then-un-logged Manna Gum flats.

I metaphorically sink knee deep into the mud of that waterlogged elbow above Lardner's Creek in the Otways where our bogged-to-the-axles Land Rover was squatting still immobile after dark when the night had a thousand eyes from the luminescent fungi. Only a moment ago I was on Chapple Creek (north branch, if you want to be pedantic) where the flat black shale beds afford an easy crossing for Morris Track.

In the Strzelecki's, I remember the big stump on a straight stretch of a well formed road near Balook (or was it Calignee?) and even have a photograph. Maybe it's still there, a stark remnant of a forest destroyed for ephemeral settlement (Fig. 1).

It's only ten years since I last stopped by the steep curve on Chimney Pot Gap in the Grampians, where the bony soil hides in pockets among the sandstone, and my cairn at the side of the road indicated the site of a rare and incredibly ancient fossil locality.

I could go on and on, beating about the bush, with midday approaching for instance, and thoughts of work jettisoned for the more urgent assessment of the site to boil the billy – one with just the requisite blend of sun and shade.

Tracks taxing the skills of my pal/field assistant, gloomy tracks, fearful tracks, almost non-existent tracks, tracks to the desert, tracks on inlets that became the sea when the tide came in ... you name them, because I've forgotten what many were called. Some for one reason or another never received a name, but when the vaults of memory open I dip through the fog patches like an early morning run on the Stony Rises, and see my country of yesteryear.

Fig 1. Big stump, Strzelecki Ranges, April 1959. Author at base.

Jack Douglas
'Kingpan', 41 Grieve Street, Warrnambool 3280.

Robert Dick, Baker of Thurso, Geologist and Botanist

At the FNCV Hall in Blackburn during the New Members Day in March, I found myself browsing along the library shelves and picked out a book called *Robert Dick, Baker of Thurso, Geologist and Botanist* by Samuel Smiles (Accession No. 251). The book was old, yellowed with age and illustrated with engravings. I noted that it was printed in 1905, although it had been written in 1878. Paragraphs such as the following led me to read on:

> 'It is sweet to stand on a hill top, and gaze far up country. Southwards you see farther than you will ever wander. Of course you cannot tell in words all that you see. You gaze eastward, northward and westward; and then after satiating yourself with the prospect, you move down the farther side of the hill, and get onward. Twelve miles, thirteen miles and many wonders to be seen';

and again:

> 'On Tuesday last I set out at two o'clock in the morning to go to the top of Morven. Morven is a hill to the south of this, and by measurement on the map 28 miles as the crow flies. But taking into account the windings and turnings of the road-up hill, down hill and along valleys - it is a good deal more; say 32 miles from Thurso to Morven top.
>
> For the first 18 miles I had a road: the rest of the way was around lochs, across burns, through mires and marshes, horrid bogs and hummocky heaths. I tucked up my trousers and felt quite at ease, though I was ankle deep and often deeper for fifteen minutes on end, and sometimes more. When I had a marsh to wade I had it level but when I had heather I had an awful amount of jumping ... At last, however, I found myself on the top of the famous Morven'.

(How reminiscent of walking on the Prom or in Tassie in the 60's!).

He arrived at the top at 11.00 am and left, after searching for plants, at 2.00 pm saying

> 'the Highlandman walks best when his feet are wet, and so does the Lowlandman, if only he could be persuaded to try'.

He got home at 3.00 am on Wednesday having walked for about 24 hours and was back at work in his bakery at 7.00 am!

> 'Sixty miles is a good walk to look at a hill. Oh those plants, those weary plants,' says Dick.

Robert Dick was born at Tullibody between the rivers Forth and Devon, Scotland in 1811. After his mother's death, a difficult family life led him to finish his schooling at age 11. He was apprenticed to a baker and later opened his own shop in Thurso in the North-East corner of Scotland. Although he never seemed to gain acceptance from the local townspeople (he remained a singularly peculiar character, dressing in out-moded clothes and wandering the sea-shore, moors and hills collecting plants, rocks, shells and bones), he nevertheless was held in high esteem by scientific men of his day and furnished many collectors with prize items for their collections.

Samuel Smiles frequently quotes Dick directly and it is a joy to feel his immense passion for the world about him. He collected every plant known in Caithness and, by swapping with other botanists, developed an almost complete collection of British Isles plants. He spent his spare time walking, collecting, reading and studying Conchology, Entomology, Botany and Geology. Spare money was spent on books which were often transported to him by ship in bags of flour!

The new sciences of Geology and Palaeontology captivated him as he toiled away with his pick-axe on the cliffs and in the quarries, turning up hundred of fossilised shells and marine animals for his own collection and that of his great friend Hugh Miller, who, like many of his time,

was trying to match fossils with the Genesis story in the Bible. Robert Dick declined to embrace such an explanation 'Let us watch for facts and wait', he said. He found Charles Darwin's theory of evolution interesting, but was cautioned by man's lack of facts and knowledge.

He was never satisfied with the observations of others and always sought to verify everything stated in the books he read. Eventually, his business failed, due to increased competition and his scrupulous honesty and, at length, his health deteriorated, his life ending in 1866 at the age of 55.

To many he was an extremely retiring man, who hated the limelight, even in print. Yet he developed deep friendships with those who demonstrated genuine interest in nature, including many students from the town's University. Those who knew him saw an intelligent, witty and cheerful man with a wide range of interests, including literature and poetry. Indeed he wrote verse, often humorous, to entertain his friends.

After his death he was given a public funeral. 'It was one of the largest, most impressive and remarkable funerals that had ever been seen in Thurso', writes Samuel Smiles. It was probably the last thing Robert Dick would have desired!

Smile writes of him -

> 'The sea was his delight. He wandered along the shores and found many things rich and beautiful and full of wonder. Though he wandered about solitary, he had no time for melancholy dreams. Every flower melted him, every star touched him, even every beetle engraved itself on his mind. He was a reverent man.'

Reading this old book, I was just as captivated by this naturalist whose life was spent in such enthusiasm; watching, searching and learning about his immediate world with the aid of his books, his microscope and like-minded friends. Many of us share this great love for our natural world and in Robert Dick's words,

> 'One cannot but admire the wisdom which gave and gives a feeling and a sense of the beautiful even to the ignorant.
> Were it otherwise, beauty would not exist and to the all-knowing how small is the difference between sage and savage'.

I am hoping to obtain my own copy of this remarkable man's story - browsing is a common path to delight!

Christy Jordan
1 Logan Avenue, Kalorama, Victoria, 3766.

Lepista nuda, the Wood Blewitt

On a sparkling but cold morning in June 1972 I was beating up one of the little creeks that drain into Waratah Bay. The creek gorge was narrow and deeply cut with sloping tussocky banks. The morning sun slanted down through the leafy canopy above in dappled patterns of light and shade.

On the northern slope a colony of large mushrooms flourished. Closer inspection showed then to be Wood Blewitts, common to most countries including ours, and a good edible mushroom. These specimens were very large and lush, heavily fluted round the edges. The cap colour of these fungi was a rich cinnamon, the frothy gills the palest mauve, the long stipes the same colour, but overlain by 'stockings' of delicate netting in dark reddish purple. As I looked up at them from below, against the light, I saw, not mushrooms, but a troupe of Can-Can dancers, each poised on one elegant leg, the other lost among the froth of mauve petticoats below the scalloped cinnamon overskirt. It was one of those occasions 'Once in a lifetime, lovely past believing'*, when one happens to be in the right place at the right time. I have been privileged to find many curious and beautiful fungi in my time but those Can-Can dancers linger in my memory.

Ellen Lyndon
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* The quote is from Judith Wright's lovely little poem 'Egrets'.

A Natural History of Australia

by Tim M. Berra

Publisher: *University of New South Wales Press, Ltd. ISBN 0 86840 4721. R.R.P. $45.00.*

Tim Berra is Professor Emeritus of Zoology at the Ohio State University, and has visited Australia to undertake research based at the Australian National University in Canberra, Monash University in Melbourne and the Western Australian Museum. He has covered over 150,000 km on field trips around Australia, taking thousands of photographs along the way. He is the author of four books and more than 50 papers in scientific journals.

His writing style is informal and easy to read, making this book a welcome addition to the bookshelves of student, specialist, naturalist or anyone with an interest in Australia's natural history. He is obviously a very experienced researcher and his 13 pages of references and further reading listed at the end are particularly useful.

The book has 304 pages, and produces an amazing quantity of information about Australia for the visitor, newcomer or resident alike. The book is set out in a logical order of time and place. Tim Berra's sometimes humourous style and obvious knowledge led me to read each chapter carefully and slowly, so as to retain just some of the vast quantity of information so expertly and beautifully presented.

Many of the wonderful photographs are the author's. The table of contents makes it very easy to look up the topics, and a tiny illustration at the bottom of each page leads you to the correct topic when flicking through the pages. Distribution maps are on the page where the information is presented, so that it is not necessary to search elsewhere for maps.

The small illustrations in the side margins are an excellent aid to identification and, in addition to the photographs, reinforce the text very well. There are up to three, sometimes four, on some pages and they add much to the visual information of the book.

Each new topic is introduced with a colourful page and an attractive layout which mostly works well, with one minor criticism. Where the page background is mottled in various colours, (e.g. p.205–207, p. 247–248) the printing becomes lost and hard to read.

In Tim's introduction to major cities and towns he cites Melbourne as being well-known for the Melbourne Cricket Ground and the Flemington race course. I would like to think that we are as well known for our extensive and beautiful city gardens, hence the well-earned reputation of Melbourne as 'The Garden City'.

In a book such as this, that traces Australia's history from plate tectonics, geological background and Gondwanan inheritance, through the evolution of flora and fauna, to language and currency, there is bound to be a few glitches. For example on page 22 the text leads nowhere at the bottom of the page and picks up again on page 25. This occurs again on page 29 with the text being picked up again on page 32. I presume this to be a printer's error, and beyond Tim's control.

I do have a few problems with some of the facts left out, although I realize one cannot present all of the facts as it would make the book unwieldy in size and content.

In the chapter on *Aerial Australia – The Birds*, it should have been mentioned that it is not only feral cats and dogs that prey on Lyrebirds, but also domestic dogs and cats and of course, foxes. Also the Superb Lyrebird does not lay its single egg **only** on the ground as stated; but can make its nest in tree ferns or in trees up to 25 m in height. I also question the statement 'that it is more bush lore than fact' that lyrebirds mimic sounds other than bird calls. If a lyrebird can mimic and learn tunes from a flute player as stated in the text, I feel it is possible for the birds to mimic chain saws, axes, train whistles, barking and panting dogs and the guttural calls of the possums.

In the same chapter it should have been pointed out that Australia has two species

of kookaburra - the Laughing Kookaburra *Dacelo novaeguineae* and the Blue-winged Kookaburra *Dacelo leachii*, the latter with quite different colouring and a very different call. It should also have been made clear in the text that only the male King parrot has a red head, not the female. The coloured illustration has been wrongly labelled. The male is on the right and the female is on the left.

Having dealt with these few criticisms, I like the way the author tackles some of Australia's really difficult issues. In the chapter that approaches the problems of *Impacts on the Flora* (p.82) he discusses the possibility of farming native animals, such as kangaroos and emus, which might be ecologically less damaging than introduced animals. He also states 'perhaps it is now time to recognise that this driest of continents should not be asked to support more inhabitants than it already has'. He also highlights Australia's loss of marsupial animals after European settlement. Since 1788, at least ten species have become extinct. This represents a large proportion of the world's mammal extinctions during the last 200 years.

Scattered throughout the book are many interesting statistics: 'Australia has the largest and the smallest crayfish in the word'; 'W.A. has 2,000 endemic species of wild flowers'; 'Sea turtles feed on sea wasps and Box jellies'; 'A single cow pad can give rise to 2,000 bush flies', and 'Thirty million cattle produce 300 million dung pads per day'. No wonder the **local** dung beetles gave up!

Tim Berra has produced a book that has contributed significantly to the natural history of Australia. Even a person who has a good knowledge of some of the topics could not fail to be impressed by this beautifully-presented and well-written book which covers such a vast range of topics so well. A book that should be on all Naturalist Club's library shelves. This book is for anyone who visits this country and has a natural history interest. Even someone like me who has lived here all her life can learn much from 'A Natural History of Australia'.

Cecily Falkingham
27 Chippewa Avenue, Mitcham, Victoria 3132.

Guidelines for Authors

Submission of all Manuscripts

Authors may submit material in the form of research reports, contributions, naturalist notes, letters to the editor and book reviews. Research reports and contributions must be accompanied by an abstract of not more than 200 words. The ***abstract*** should state the scope of the work, give the principle findings and be complete enough for use by abstracting services. Research reports and some contributions will be refereed. A ***Research Report*** is a succinct and original scientific paper written in the traditional format including abstract, introduction, methods, results and discussion. A ***Contribution*** may consist of reports, comments, observations, survey results, bibliographies or other material relating to natural history. The scope of a contribution is broad and little defined to encourage material on a wide range of topics and in a range of styles. This allows inclusion of material that makes a contribution to our knowledge of natural history but for which the traditional format of scientific papers is not appropriate. ***Naturalist Notes*** are generally short, personal accounts of observations made in the field by anyone with an interest in natural history. These may also include reports on excursions and talks, where appropriate.

Submission of a manuscript will be taken to mean that the material has not been published, nor is being considered for publication, elsewhere.

Three copies of the manuscript should be provided, each including all tables and copies of figures. Manuscripts should be typed, double spaced with wide margins and pages numbered. The name and address of all authors should be on a separate page to ensure anonymity for refereeing. Indicate the telephone number of the author who is to receive correspondence.

Please note that we use the desk-top publishing programme PC Quark Xpress which only accepts MSWord for Windows 2. Thus, the editors would prefer the disc (required only for the final paper) in this programme. However, we can deal with most PC programmes.

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Authors can verify their final copy manuscript before it goes to the printer. A copy of their article as 'ready for the printer' will be sent and final changes may be made at this stage.

Taxonomic Names

Cite references used for taxonomic names. References used by *The Victorian Naturalist* are listed at the end.

Abbreviations

Italics are used for the following abbreviations: *et al.*; *pers. comm.*; *pers. obs.*; *unpubl.* and *in press* which are cited in the text - (R.G.Brown 1994 *pers.comm.* 3 May). Note that 'ssp.' is now 'subsp.'

Tables and Figures

All illustrations (including photographs) are considered as figures and will be designed to fit within a page (115 mm) or a column (55 mm) width. Tables must also fit into 55 mm/115 mm. **It is important that the legend is clearly visible at these sizes.** For preference photographs should be of high quality/high contrast which will reproduce clearly in black-and-white and they may be colour slides, colour or black-and-white prints. Line drawings, maps and graphs may be computer generated or in black Indian Ink on stout white or tracing paper. On the back of each figure, write the figure number and the paper's title in pencil. All figures and tables should be referred to in the text and numbered consecutively. Their captions must be numbered consecutively (Fig. 1, Fig. 2, etc.) and put on a separate page at the end of the manuscript. Tables should be numbered consecutively (Table 1, Table 2, etc) and have an explanatory caption at the top.

Units

The International System of Units (SI units) should be used for exact measurement of physical quantities.

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Authors are advised to note the layout of headings, tables and illustrations as given in recent issues of the Journal. **Single spaces** are used after full stops, and **single quotation marks** are used throughout (in most cases).

In all papers, at the first reference of a species, please use both the common name and binomial. However, where a lot of species are mentioned, a list (an appendix at the end), with both common and binomial names, may be preferred.

The journal uses capitalised common names for species then the binomial in italics e.g. Kangaroo Grass *Themeda triandra*.

References

References **in the text** should cite author and year e.g. Brown (1990), (Brown 1990), (Brown 1990, 1991), (Brown 1995 *unpubl.*), (Brown and Green 1990), (Brown and Green 1990; Blue 1990; Red 1990). If there are more than two authors for a paper use (Brown *et al.* 1990). These should be included under **References,** in alphabetical order, at the end of the text (see below). The use of unpublished data is only accepted if the data is held in a public institution, and the location must be cited in the references. *Pers. obs.* and *pers. comm.* should not be included in the list of references.

Journal titles should be quoted in full.

Leigh, J., Boden, R. and Briggs, J. (1984). 'Extinct and Endangered Plants of Australia'. (Macmillan: Australia).

Lunney, D. (1995). Bush Rat. *In* 'The Mammals of Australia'. Ed. R. Strahan. (The Australian Museum and Reed Books: New South Wales).

Phillips, A. and Watson, R. (1991). *Xanthorrhoea*: Consequences of 'Horticultural Fashion'. *The Victorian Naturalist* **108**, 130-133.

Smith, A.B. (1995). Flowering plants in north-eastern Victoria. (Unpublished PhD thesis, Melbourne University).

Other methods of referencing may be acceptable in manuscripts, other than research reports, and the editors should be consulted. For further information on style, write to the editors or consult the latest *Victorian Naturalist.*

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Checking species names is the responsibility of authors. The books we would like to be used as references for articles in *The Victorian Naturalist* are listed below. **Authors should refer to the sources used in their papers.** In every case, the latest edition of the book should be used.

Mammals - ***Mammals of Victoria***, edited by Peter Menkhorst, Oxford University Press 1995.

Reptiles and Amphibians - ***Reptiles and Amphibians of Australia***, Harold Cogger, Reed Books 1992.

Insects - ***The Insects of Australia***, CSIRO 1991.

Birds - ***The Taxonomy and Species of Birds of Australia and its Territories***, Leslie Christidis and Walter Bowles, RAOU Monograph 2 1994.

Plants - ***A Census of the Vascular Plants of Victoria***, edited by J.H. Ross, Royal Botanic Gardens of Victoria 1996.

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Improving Nature? The Science and Ethics of Genetic Engineering.

by Michael J. Reiss and Roger Straughan.

Publisher: *Cambridge University Press. ISBN 0-521-63754-6. 228 pages. RRP: Hardback $39.95 Paperback $25.95.*

These days we are hearing more and more about the benefits and dangers arising from the genetic manipulation of our food, medicines, flora and fauna. More often than not, the general concepts that we have about genetically engineered organisms are formed from misinformation, confusion on the part of journalists, and the potentially biased opinion of the genetic engineers themselves. What is needed is a way of sorting through and judging the information presented to distinguish between fact and propaganda. This book goes a long way to providing the background knowledge necessary to be able to do just that.

This book, the result of a collaboration between a biologist and a moral philosopher, makes an effort to explain the science and the moral philosophy behind this topic in a way that is accessible to lay persons. As someone with no specialised knowledge in the area, I found both the science and the philosophy easy to follow. For anyone with concerns in this area, who does not necessarily want to wade through text books on genetics, I would thoroughly recommend this book. Likewise, I would encourage any concerned individuals who are doing biotechnology degrees to read this book.

Genetic engineering is the process of creating organisms with specific, novel genetic constitutions, whether it be selectively breeding a plant to produce different coloured flowers, or inserting human DNA into animals to provide transplant organs for the medical profession. Other words used to describe this process include 'genetic manipulation', 'genetic modification', 'genetic technology', 'recombinant DNA technology' and 'modern biotechnology'.

The book is divided into three sections. The first introduces the basic concepts with an explanation of the practicalities of genetic engineering and a lovely, brief explanation DNA, cell division, mutations and the basic principals of genetic engineering. It then outlines the moral and ethical concerns and goes into particular detail on theological concerns.

Part two presents a series of case studies that highlight the ethical and moral concerns with genetic engineering. Case studies start by looking at the genetic engineering of microorganisms, such as the bacterium that has been changed to produce human insulin, then working through the genetic engineering of plants, then animals, and finally humans. The science behind each case study is described, and then the implications are analysed in terms of ethical principals. It is this blending of science and ethics that makes this book particularly valuable. Part three investigates public understanding of the issue and the role of education.

The great value of this book is in its presentation of both sides of the argument in clear, unemotive language, and then the explanation of the valid and invalid points on each side. It does not attempt to draw conclusions, but rather leaves the reader to judge the relative merit of the arguments and decide for themselves.

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Cover: A Swamp Hen nest among *Myriophyllum simulans, Triglochin procerum* and *Rumex bidens* at Stony Rises, Victoria (see p. 149). Photo courtesy Nick Romanowski.

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Nectar Robbing in *Epacris impressa* (Epacridaceae) by the Recently Introduced Bumblebee *Bombus terrestris* (Apidae) in Tasmania

Andrew B. Hingston[1,2] and Peter B. McQuillan[1]

Abstract

The frequency of nectar robbing by *Bombus terrestris* (L.) was compared between two populations of Common Heath *Epacris impressa* Labill. in southern Tasmania. Robbing was more frequent in the population with longer corollas, resulting in most open flowers being pierced. As these corolla tubes were shorter than most Victorian flowers of the same species, it is likely that *B. terrestris* would also rob flowers of *E. impressa* in Victoria if it crosses Bass Strait.
(*The Victorian Naturalist*, **115 (4)**, 1998, 116-119).

Introduction

The Large Earth Bumblebee *Bombus terrestris* (L.) was first recorded in Australia in the Hobart suburb of Battery Point on 19 February 1992 (Semmens *et al.* 1993). It has subsequently spread rapidly across Tasmania (Semmens 1996), but has not yet been recorded from the Australian mainland. In southern Tasmania it occurs at high densities in a wide variety of native vegetation types including coastal heath, dry sclerophyll forest, and subalpine shrubbery up to an altitude of 1100 m. Within these habitats it forages on a wide range of plants (polylecty), being recorded from 66 native species from 21 families between September 1996 and June 1997 (Hingston and McQuillan in press), raising concerns of adverse ecological consequences.

One concern involves the well known tendency for this species to obtain nectar from flowers with tubular corollas by piercing them (e.g. Hawkins 1961; Morrison 1961; Holm 1966; Barrow and Pickard 1984; Donovan and Macfarlane 1984; O'Toole and Raw 1991). Studies on other plants have found that robbing is more prevalent in bumblebee workers and drones than in the larger queens (Carpenter 1979; Fussell 1992).

The most common plant with tubular flowers in Tasmania is Common Heath *Epacris impressa* Labill. (Epacridaceae). This species was the second most frequently visited (after Manuka *Leptospermum scoparium* J.R. & G. Forst.) by *B. terrestris* during 1996-97 near Hobart (Hingston and McQuillan *in press*), with nectar being accessed both through the corolla throat and by piercing the corolla.

We were investigating whether the relationship between bumblebee tongue length and flower corolla tube length was related to the frequency of nectar robbing at *E. impressa* in two populations near Hobart by *B. terrestris*. Subsequent comparison of corolla lengths between *E. impressa* in Victoria and these populations allowed speculation on the likelihood of the flowers of *E. impressa* in Victoria being robbed by *B. terrestris* if the bee were to cross Bass Strait.

Methods

Bumblebees were observed while foraging on *E. impressa* at two areas in southern Tasmania on 13 days between January and April 1997, and the numbers accessing nectar legitimately (via the corolla throat) and by robbing (piercing the corolla tube) were recorded. As tongue length is proportional to body size within a *B. terrestris* colony (Dafni and Shmida 1996), body lengths were used as an indication of tongue lengths. Measurements were made using a 30 cm ruler with 1 mm graduations on random samples of workers and drones captured at both sites between 20 December and 7 February 1997. A random sample of the corolla tube lengths of flowers was measured by the same method in early March at both sites, with only one flower being sampled per plant.

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The study sites were: Coffee Creek, consisting of heathy Black Peppermint *Eucalyptus amygdalina* Labill. coastal forest on Triassic sandstone at an altitude of 10–50 m; and Hobart from Mt Nelson to Waterworks Reserve, where dry sclerophyll forest grew on Jurassic dolerite at an altitude of 150–250 m.

Results

Most workers and drones, and all but one of the queens, foraging on *E. impressa* at Coffee Creek accessed nectar legitimately (Table 1). However at Hobart, workers and drones usually robbed flowers. Only four queens were observed foraging on *E. impressa* at Hobart, with all of these also piercing the corolla (Table 1). These differences in foraging behaviour between the two populations were statistically significant for workers and drones ($\chi^2 = 150.81$, $p < 0.001$) and for queens ($\chi^2 = 24.69$, $p < 0.001$).

Bombus terrestris appeared responsible for all corolla piercing, as no other animals were observed robbing flowers at either site. The high proportion of individuals robbing flowers at Hobart resulted in virtually all corollas being pierced by the end of February, raising the possibility of a major impact on this population.

The distributions of worker and drone body lengths at both sites differed significantly from these expected from populations with normal distributions ($p = 0.0064$, Kolmogorov-Smirnov Normality Test). Consequently, the non-parametric Mann-Whitney Rank Sum Test was employed to compare body lengths between populations. This test demonstrated that the workers and drones at Hobart were significantly shorter than those at Coffee Creek ($T = 5938.0$, $p < 0.0001$) (Table 2).

The distributions of corolla lengths at both sites also differed significantly from those expected from populations with normal distributions ($p < 0.0001$, Kolmogorov-Smirnov Normality Test). Corollas were significantly longer at Hobart than at Coffee Creek ($T = 6177.0$, $p < 0.0001$, Mann-Whitney Rank Sum Test) (Table 2). However, the corollas at Hobart were still shorter than those in many Victorian populations (Table 3).

Discussion

The discovery of more frequent nectar robbing at Hobart, where *E. impressa* corollas were longer and *B. terrestris* workers and drones were smaller, is consistent with the hypothesis of robbing occurring when nectar cannot be reached via the throats of tubular flowers (Willmer and Corbet 1981).

If *B. terrestris* becomes established in Victoria it is very likely that nectar robbing will also be the predominant foraging technique there because all red, all pink, and some white corollas in Victoria are as long or longer than those at Hobart (Stace and Fripp 1977). Hence, if they cross Bass Strait, *B. terrestris* can be expected to rob a large proportion of Victorian *E. impressa*, providing that their flight periods and flowering phenologies overlap.

Table 1. Numbers of *Bombus terrestris* observed accessing *Epacris impressa* nectar via the corolla throat and by piercing the corolla.

Castes	Sites	Robbing	Legitimate	% Robbing
Workers	Hobart	112	20	84.8
and drones	Coffee Creek	18	133	11.9
Queens	Hobart	4	0	100.0
	Coffee Creek	1	27	3.6

Table 2. Length distributions for workers and drones of *B. terrestris* between 20 December 1996 and 7 February 1997, and corolla tubes of *E. impressa* during the first week of March 1997, at Hobart and Coffee Creek.

Variable	Site	n	25% quartile	Median	75% quartile	Range (mm)
Workers	Hobart	104	15.0	16.5	18.0	11-21
& drones	Coffee Ck	58	17.0	18.0	20.0	14-21
Corollas	Hobart	60	10.5	11.0	13.0	9-15
	Coffee Ck	86	9.0	9.5	10.0	6-13

Table 3. Ranges of corolla lengths (mm) of *Epacris impressa* from various regions. Victorian data from Stace and Fripp (1977).

Site	Colour	Range
Hobart	pink	9.0-15.0
Coffee Ck	pink and white	6.0-13.0
Victoria	white	8.6-13.2
W. Victoria	pink	11.0-16.0
E. Victoria	pink	15.0-22.0
Victoria	scarlet	17.0-20.0
Grampians (var. *grandiflora*)	red and white	12.0-17.0

This nectar robbing may influence the reproductive success of *E. impressa.* Because individuals involved in robbing other species usually do not contact the anthers and stigmas (Morrison 1961; Holm 1966; Donovan and Macfarlane 1984; O'Toole and Raw 1991) (but see Macior 1966), seed-set may be adversely affected through lack of pollen transfer between flowers (Dafni and Shmida 1996). Although *Bombus affinis* Cresson queens pollinate Columbine *Aquilegia canadensis* L. flowers which they rob, because they land on the anthers and stigma prior to piercing the nectar spur (Macior 1966), this is unlikely to occur when *B. terrestris* robs *E. impressa* because the anthers are within the corolla tube.

Seed-set may also decrease as the result of reduced numbers of visits by legitimate visitors in response to lower nectar levels following robbing (Pyke 1990; Dafni and Shmida 1996). However a plant's reproductive organs are not damaged by robbing, allowing pollination to occur through subsequent legitimate nectar and/or pollen collection (Donovan and Macfarlane 1984). Indeed, it has been proposed that the reduction in nectar levels due to robbing may force legitimate nectarivores to visit more flowers per unit time, thereby increasing seed-set (Heinrich and Raven 1972).

However, some visitors which would otherwise access the nectar via the corolla throat may become secondary robbers by extracting nectar through the holes made by *B. terrestris* (Morrison 1961; Holm 1966; Barrow and Pickard 1984; O'Toole and Raw 1991). Although this would be expected to have adverse effects on pollination one such case in Red Clover actually enhanced seed-set (Hawkins 1961). Holes in corollas resulting from robbing (mostly by *B. terrestris*) allowed access to nectar by European Honey Bees *Apis mellifera* L., which attracted more of them to the crop. *Apis mellifera* also gathered pollen from Red Clover, and in so doing transferred it between flowers of this obligate outcrossing species, thereby increasing seed-set (Hawkins 1961).

It is thus difficult to predict the impact of nectar robbing on the fecundity of *E. impressa*, although any impact may eventually alter plant community structure (Aizen and Feinsinger 1994). Consequently, further research is necessary to determine how the overall reproductive success of *E. impressa* is affected by the nectar robbing of *B. terrestris* ahead of attempts to introduce *B. terrestris* formally to other Australian states as a consequence of the active promotion of its agricultural potential (e.g. Semmens 1995). As *B. terrestris* moves shorter distances between flowers while foraging than do smaller bees (Herrera 1990), its effect on outcrossing rates in native plant species is also worthy of investigation.

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Rabbit Control

Rabbits are a continuing problem for farmers, local government, park managers. For groups involved in revegetation and habitat restoration, the costs of tree guards and replacing eaten plants can be considerable

In a recent issue of Indigenotes, we saw information on a new method to help control rabbit numbers. Known as 'Rid-a-Rabbit, it uses LP gas to kill rabbits. The gas is released down the rabbit burrow and then ignited with an electronic probe. The resultant rush of ignited gas through the burrow burns up the available oxygen and the rabbits die in about 45–120 seconds from lack of oxygen.

This unit is small and portable and allows easy access to difficult-to-reach areas, and would appear ideal as a simple, effective, environmentally friendly and humane alternative to fumigation. Current users include New South Wales National Parks and Wildlife Service, Landcare Groups in Victoria and a number of farmers.

The unit is Australian made and invented, and costs around $2450.00 to buy and operating costs are about two cents a rabbit hole, which is a cheap method when money is tight.

Further information can be obtained from Rid-a-Rabbit Marketing, PO Box 423 Bulleen, Victoria 3105. Telephone (03) 9841 4507.

The Editors

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A Small Mammal Community Living in a Powerline Easement at Bunyip State Park, Victoria

Jackie Macreadie[1], Robert L. Wallis[1] and Robyn Adams[1]

Abstract

Small mammals living in a powerline easement that had been cleared of trees were surveyed in Bunyip State Park in Gippsland, Victoria. Five species of native mammals were detected either by trapping or using hair tubes, including the rare Broad-toothed Rat *Mastacomys fuscus*. All five species presumably occur in the surrounding forest. This study is unusual in its failure to detect small mammal species that are either typical of grasslands or are introduced.

(*The Victorian Naturalist*, **115 (4)**, 1998, 120-123).

Introduction

Clearings are maintained under high voltage power transmission lines for servicing and for fire control. In forests, these clearings typically comprise grassy swathes with occasional low shrub layers. Powerline clearings can thus act as linear barriers to movement of animals between forest patches and can have impacts on the conservation of forest fauna. Two studies in Australian forests have demonstrated that movements of forest dwelling small mammals are inhibited by powerline corridors (Goosem and Marsh 1997, Goldingay and Whelan 1997). These support other reports that linear barriers such as roads have a similar effect, both in Australia (Mansergh and Scotts 1989, Andrews 1990, Burnett 1992, Goosem 1997) and in the Northern Hemisphere (Oxley *et al.* 1974, Schreiber and Graves 1977, Mader 1984).

Another impact powerline corridors have been shown to have is to allow movement of non-forest species along the corridor (Anderson *et al.* 1977, Schreiber and Graves 1977, Johnson *et al.* 1979, Kroodsma 1982, Goosem and Marsh 1997).

In all of the reports mentioned above there is a clear implication that the establishment of powerline easements with associated habitat modifications is deleterious for the resident forest fauna.

In this study we report on the small mammals living in a powerline easement within a forest in Victoria. We show that five species of small native mammal were found living in the cleared easement, including the rare rodent Broad-toothed Rat *Mastacomys fuscus*.

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Study Site

Bunyip State Park is a 16000 ha forest in the foothills of the Great Dividing Range, 65 km east of Melbourne. The Park is bounded on the east and north by Gembrook Park. Grazing properties adjoin the east and southern boundaries. Bunyip State Park has been recommended for listing as part of the National Estate in recognition of its outstanding natural values with many land types, a rich flora (over 400 species, including eight of state significance) and fauna (54 species of mammals, 24 reptiles, 140 birds).

The study site is located in the southeastern corner of the Park on the edge of the Tynong Granite Block. The easement is about 100 m wide and was cleared in 1962 for the 500 kV transmission lines which run from Morwell to Melbourne (Fig. 1). The easement bisects the Park, running from its southeast corner to the north west corner.

The surrounding forest is dominated by Narrow-leaved Peppermint *Eucalyptus radiata*, with a thick understorey of Yellow Hakea *Hakea nodosa* or a thick ground layer of Thick Twig-rush *Caustis pentandra*, Thatch Saw-sedge *Gahnia*

Fig. 1. The powerline easement.

radula and a range of grasses. Three drainage lines cross the easement and the study site included not only these wetter areas, but also drier slopes.

Methods and Results

Vegetation

A section 400 m long was chosen as the study site. The width of the cleared easement ranged from 100 to 120m.

Quadrats of 16m^2 were sampled in the summer of 1996/97 in the easement and vegetation identified and cover/abundance estimated using the DOMIN Cover Scale (Kershaw and Looney 1985). Data from 121 quadrats were analysed by PATN (Belbin 1991). The two-way table of data produced suggested vegetation comprised a single community with three types, related to a moisture gradient:

1. *Leptospermum - Gahnia type.*

This vegetation type is widespread along the drainage lines. The upper stratum contains Prickly Tea-tree *Leptospermum continentale* and Scented Paperbark *Melaleuca squarrosa. Leptospermum lanigerum* is sometime found in the better drained sites. Lower strata species in the better drained parts include Wiry Bauera *Bauera rubioides,* Wiry Coral-fern *Gleichenia dicarpa, Gahnia radula* and Swamp Bush-pea *Pultenaea weindorferi. Gleichenia dicarpa* was the main understorey species in the wetter zones under a dense thicket of *M. squarrosa* which could reach 7 m height.

2. *Bauera-Gahnia type.*

This vegetation occurs on better drained soils. It has fewer tall shrubs and is dominated by a continuous stratum of low (<120 cm) cyperaceous and restionaceous sedges with abundant *Bauera rubioides* and *Gahnia radula.* Patches of *Gleichenia dicarpa*, *Bracteantha bracteata* and mosses are common.

3. *Banksia-Acacia type.*

The crests of the easement have the driest soils, and the vegetation contains eucalypt saplings (mainly *Eucalyptus radiata*) with a low shrub layer of Silver Banksia *Banksia marginata,* Hairpin Banksia *B. spinulosa,* Heath Wattle *Acacia brownii* and *Hakea nodosa.* Ground stratum species include *Schoenus tenuissmus, Caustis pentandra,* Screw Fern *Lindsaea linearis* and poa grasses.

The easement is slashed about every four years. Vegetation types 2 and 3 are especially affected, while type 1 habitat may miss such frequent cutting because it occurs in natural depressions. The vegetation types are more distinguished by structural differences and frequencies of occurrence of species rather than actual species present.

Mammal survey

Three trapping grids were set up spanning three drainage lines which ran across the easement. Each grid contained six rows of six trapping stations. Stations were set 15 m apart. Rows were set 20 m apart. Two trap stations in each row were placed in the forest adjoining the easement and a third station at each row was set up in a sapling regrowth zone between the forest edge and the slashed section of the easement. Wire mesh cage traps (37 × 13 × 13 cm) and Elliott folding aluminium traps (33 × 10 × 10 cm) were baited with a mixture of rolled oatmeal, honey and peanut butter and set at each station at dusk and cleared near dawn from September to January (5 months). Animals were identified and released at the point of capture. Hair tubes (38 mm diameter, 100 mm long) baited with the same bait were set at each station. The tubes had one end pinched to maximize hair retrieved from animals of different sizes.

We obtained 750 captures of small mammals in the traps (from 2180 trap nights) and 713 tubes (of the 2095 set) contained hair over the five month study. The results are presented in Table 1. The native rodents Swamp Rat *Rattus lutreolus* and Bush Rat *R. fuscipes* were the most frequently captured mammals (394 and 186 respectively). There were 59 captures of *Mastacomys fuscus* (Fig. 2). Other species trapped were the Agile Antechinus

Fig. 2. *Mastacomys fuscus.*

Table 1. Occurrences of small mammals in the three vegetation types. The numbers in brackets represent the ratio of the number of mammals found (trapped or detected in hair tubes) to the number of trap sites.

	Bauera-Gahnia	***Banksia-Acacia***	***Leptospermum-Gahnia***	**No. of animals trapped**	**No. of tubes with hair of this species**
No. of trap stations	51	54	10		
Rattus lutreolus	420 *(8.2)*	140 *(2.6)*	94 *(9.4)*	394	260
Rattus fuscipes	108 *(2.1)*	189 *(3.5)*	48 *(5)*	186	160
Mastacomys fuscus	164 *(3.2)*	35 *(0.65)*	10 *(1)*	59	150
Antechinus agilis	73 *(1.4)*	118 *(2.2)*	22 *(2.2)*	93	120
Antechinus swainsonii	0 *(0)*	0 *(0)*	35 *(3.5)*	18	17

Antechinus agilis and the Dusky Antechinus *A. swainsonii.* Similar data were obtained from the hair tubes, although *M. fuscus* occurred more frequently in the hair tubes (21% of all samples versus 8% of mammals trapped).

No *M. fuscus* were trapped or detected in tubes at stations in the eucalypt forest or under eucalypt saplings (stations 1–3 in each row). Eighty five percent of *M. fuscus* occurrences (in traps or in tubes) occurred in the *Bauera-Gahnia* vegetation type which comprised 45% of the sites examined. Nine percent of occurrences were in the *Banksia-Acacia* vegetation (47% of available sites) and the remainder were in the *Leptospermum-Gahnia* sites (8%).

Rattus lutreolus were also more frequently captured in the *Bauera-Gahnia* vegetation (420 occurrences) than either the *Banksia-Acacia* vegetation type (140) or the *Leptospermum-Gahnia* type (94). In contrast, both *R. fuscipes* and *A. agilis* were recorded most frequently in the *Banksia-Acacia* vegetation (192 for the rats, 128 for the antechinus) with fewer records in the *Bauera-Gahnia* vegetation (110 rats, 80 antechinus) and the *Leptospermum-Gahnia* type (50, 25 respectively).

Several diggings and one scat of *Isoodon obesulus* were seen on one occasion in the easement in the north west of the study site.

Discussion

At least five native species of small mammals were found living in the powerline easement in which tree cover had been removed. The extent to which these species are also living in the surrounding open forest is unknown, although all species have been previously reported as occupying forest habitat (Menkhorst 1995). This appears to be the first report of such a rich assemblage of small mammals living in such a corridor. Others elsewhere have reported that cleared powerline easements are invaded by typically grassland species, non-forest or introduced species which invade along the easement (Johnson *et al.* 1979, Goldingay and Whelan 1997, Goosem and Marsh 1997). That no introduced rodents were detected at our study site in what is such an obviously modified habitat is unusual.

Some 160 hair tubes contained evidence of *M. fuscus* and 59 animals were trapped. In contrast, more *Rattus* spp. were trapped than detected using hair tubes. This confirms previous reports that in many locations *M. fuscus* is more difficult to trap than other sympatric rodents and that hair tubes or other indirect detection methods (such as predator scat analysis) can be more successful in locating this species (Wallis *et al.* 1982, Wallis 1992). *Mastacomys fuscus* is classified rare in Victoria. Although its distribution is fairly widespread, from the Otway Ranges to the Alpine National Park, its populations are highly disjunct (Menkhorst 1995). This population in Bunyip State Forest is thus of conservation significance and the habitat in the powerline easement will need to be managed sensitively to ensure its survival.

Our data suggested that *R. lutreolus* and *M. fuscus* were more commonly detected in the wetter habitat with a dense sedge cover. *Mastacomys fuscus* was especially likely to be found in the *Bauera-Gahnia* vegetation type. All 35 detections of *A. swainsonii* occurred in the dense, wet, well-covered *Leptospermum-Gahnia* vegetation type, in contrast to *A. agilis* and *R. fuscipes,* which were found in all three habitat types.

Further work planned at the site aims to determine the movements of, and specific habitat use by, animals living in both the forest and the corridor. We also hope to compare densities of small mammals in the forest and in the easement, and to assess the significance of any edge effects on small mammals (Goldingay and Whelan 1997).

Acknowledgments

We thank Hans Brunner who found the site originally and whose vast experience as a naturalist made him certain it harboured Broad-toothed Rats. Hans also ably assisted in project design and hair identification. We thank Greg Young and David Drangsholt, rangers for Bunyip State Park for their help and Richard Hoy and Joe Boulton from GPU PowerNet for their support and encouragement. Trapping was carried out under permit number 967/075 from the Department of Natural Resources and Environment.

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Review Publication of the Year Award
The Victorian Naturalist - Shortlisted

We were very pleased to be advised the *The Victorian Naturalist* had been considered for this award, along with six other publications - *Australian Book Review, The Australian's Review of Books, The Australian's Saturday Book Review pages, Fastbooks' previews website*, *The Good Weekend* (for features rather than reviews), and *The Rockhampton Morning Bulletin book reviews*.

Publish Australia, a group of about 40 independent, Australian-owned publishers decided to award this honour to the media outlet which provided the best quality and quantity of reviews of Australian books.

The Victorian Naturalist was nominated by Marie Foster, Sales and Marketing Manager, University of New South Wales Press, and we thank her for putting our journal forward.

Although we didn't win, we believe that the short listing reflects very well on our journal, and we thank our book reviewers for their excellent work.

Congratulations to you all.

The Editors

A Study of the Warrandyte State Park Orchid Flora from 1991 to 1997

Pat Coupar[1] and David Van Bockel[2]

Abstract

Warrandyte State Park lies on the suburban fringe, just 24 kilometres from the Melbourne GPO. The hills around Warrandyte are renowned for their orchid displays, however, over the last 10 to 20 years the number and diversity of orchids has significantly declined. This is mainly due to an alarming increase in rabbits and competition from weeds. A detailed study of the Warrandyte State Park orchid flora was carried out from 1991 to 1997. The study involved the verification of old records, general orchid surveys in all areas of the State Park, as well as systematic searches for particular species. The results show that of the 67 species recorded for the Park, around 80% are threatened with local extinction over the next 10 to 40 years. The findings led to management strategies directed at the conservation of Warrandyte's orchids. These have included the construction of several rabbit exclusion fences around areas of high orchid diversity, weed control and regular monitoring. In three of the fences the number of orchid species increased significantly over a two year period following construction of the fences. Hand pollination of certain species is currently being trialled as another means of increasing orchid numbers. (*The Victorian Naturalist* **115 (4)**, 1998, 124-131).

Introduction

Orchids are one of the most admired and studied groups of all flowering plants. The fascination of orchids is due, in part, to the infinite variety of shapes and colours of their flowers. The fact that many species are so elusive, is an added attraction.

The sometimes bizarre arrangement of floral parts, bright colours and scent are all part of the lure to attract insects for pollination. Many orchids have an intimate relationship with their pollinator, in some cases relying on a single species of native wasp, bee, fly or gnat to perform this function. This high degree of specialisation, together with their need to associate in varying degrees with mycorrhizal fungi in the soil, has resulted in a precarious existence for many orchids. In Victoria alone, over 100 orchid species are threatened with extinction, 50 of these are endangered and three are believed to be extinct already (Backhouse and Jeanes 1995).

The main cause for the decline in orchid species and numbers is, without doubt, habitat degradation and destruction. Any disturbance of native bushland is usually followed by invasion of weeds, notably exotic grasses which out-compete many indigenous plants, including orchids. Additional threats come from introduced pests, particularly rabbits which not only graze vegetative parts above the ground, but dig up the fleshy tubers as well. Slugs, snails and millipedes also damage orchids by chewing through stems and flower-buds denying the plant the opportunity to reproduce from seed.

Orchids, with their exotic ephemeral beauty, are the equivalent of butterflies in the plant world and have long suffered the same fate - that of illegal collection. Under the Flora and Fauna Guarantee Act (FFG Act) of 1988 (Parliament of Victoria, 1988), all orchids are protected on public land. In addition, threatened species listed under the FFG Act are protected on all land, both private and public. This, however, does not ensure their safety from poachers and on occasions it is necessary to keep the location of some extremely rare species a secret.

Due to their diversity, wide distribution, adaptation to many habitats and sensitivity to habitat changes, orchids are an excellent indicator of the health of ecosystems and the effectiveness of conservation initiatives and strategies (Backhouse and Jeanes 1995). When an area of bushland suffers disturbance, orchids are usually the first plants to decline. Our study of the Warrandyte flora has shown this to be the case.

History

The township of Warrandyte is situated alongside the Yarra River, 24 km north-east of Melbourne GPO, on the urban-rural fringe. In 1975, 135 ha of crown land, incorporating Pound Bend, Jumping Creek

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and Black Flat reserves, was officially declared as the Warrandyte State Park (WSP). Over the next 12 years several other parcels of land were added to the Park to make a total area of 586 ha (Department of Conservation and Environment 1990). In June 1997 two additional blocks, Mount Lofty and Scotchman's Hill, were incorporated into the Park increasing its size to 690 ha (Fig. 1).

The Park consists mostly of Box-Stringybark woodland and herb-rich foothill forest with a narrow linear strip of riparian forest along the Yarra River. The dry slopes and ridges, where most of the orchids occur, are open forest dominated by Red Box *Eucalyptus polyanthemos*, Red Stringybark *E. macrorhyncha*, and Long-leaf Box *E. goniocalyx* with an understorey of wattles, cassinias, peas, native grasses and wildflowers. Due to the fragmented nature of the Park, much of the open forest areas containing the greatest diversity of orchid species are bordered by streets and houses. This situation has created enormous pressures on the biodiversity of the Park as do the high visitor numbers - approximately 300,000 day visitors per year (Warrandyte State Park Management Plan 1990). In addition, being a State Park, a number of recreational activities are allowed including horse riding, bike riding and 'dogs on leads' in designated areas.

The majority of forest in and around Warrandyte State Park is regrowth. The area has a history of gold mining stretching back to the 1850's. Much of the forest was cleared during this time, the timber being used for fencing and mining props. Indeed, relics from that era can still be seen in some areas of the State Park. Warrandyte has also suffered a number of devastating wildfires in 1939, 1962, 1969 and more recently in 1991 when about 60 ha was burnt at Pound Bend.

Flora surveys

There have been a number of surveys of Warrandyte's flora over the years. In 1969, a plant list was prepared for the report 'Proposal for Warrandyte State Park' (Aldor *et al.* 1969). In 1982, Phil Smith (a botanist for the then National Parks Service) produced a list of flora for the Pound Bend Reserve and the Russell Road Reserve. Previous rangers at the Park, Scott Coutts and Kris Reinertsen and local naturalists Cecily Falkingham, John Reid,

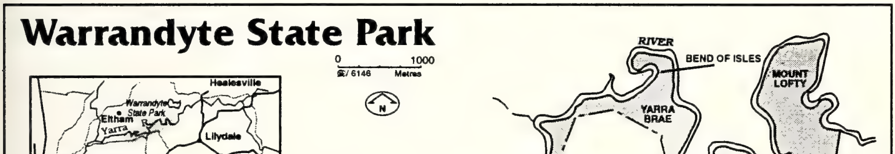

Fig. 1. Warrandyte State Park, Victoria. Location map.

Graham Jarrett and the late Bill King, have all provided valuable information on the locations of rare plants and in particular the orchids. A number of local residents have also contributed their records. By far the most comprehensive plant list, however, was compiled in 1981 by amateur naturalist Arthur Williamson, from his observations of the Warrandyte flora from the 1960's to the early 80's.

In 1991 we began our own survey with the intention of updating Arthur Williamson's existing list and incorporating records from all other sources. One of the drawbacks of Williamson's list was that no specimens had been collected, although many of the plants had been photographed on slide film and the Melbourne Herbarium was able to verify some species from these slides.

In the search for information we spoke to a number of long-term local residents and naturalists who had visited the area regularly and were familiar with Warrandyte's orchid species. Sadly, they all reported a serious decline in orchid species and numbers, especially over the past 10 years. For example, Jeff Jeanes noticed that three species of *Caladenia* (*C.lindleyana, C. praecox* and *C. caerulea*) have declined at the Timber Reserve. He also observed that the previously high numbers of hybrid *Diuris* swarms were no longer present, due to the low number of the parent species (*D. pardina, D. lanceolata, D. corymbosa and D. sulphurea*) (Jeanes, J. *pers. comm.*).

A considerable time was spent with Arthur Williamson, both in the field and studying his records, in an attempt to locate plants which we had been unable to find in the Park. A calendar was prepared, listing the orchids not yet found, mapping their last known location, date last seen and the month they were most likely to be flowering.

Between 1991 and 1996 we undertook many field trips to survey the plants in all areas of the State Park. No formal quadrats were set up, but large areas were covered by simply walking off tracks through the bush. The surveys were carried out mostly in winter and spring and often we came across orchid leaves which we could not identify. The sites of these unidentified leaves were marked with tape attached to a nearby tree and their location was marked on a map, with a reminder to return to them at a later date when we estimated they might be in flower. In addition, a wire guard (approximately 60 cm tall by 30 cm wide) was placed around the leaves to protect them from rabbits.

Each species of orchid found in flower was photographed, both close up and in habitat, collected and pressed. No tubers were taken, but a flower of each species was preserved as a 'wet collection' (a solution of 75% ethyl alcohol in distilled water). The specimens were lodged and identified at the Melbourne Herbarium and a duplicate specimen kept at the Park office.

Systematic searches for particular orchid species were also carried out in conjunction with contract botanists, the Friends of Warrandyte State Park (FOWSP) and other interested volunteers. More recently, David Cameron, Senior Botanist for the Department of Natural Resources and Environment (DNRE), contributed field survey and identification time, and assisted in setting up five permanent quadrats for monitoring the effects of prescribed burning on the structure and floristics of the vegetation.

The major findings of the study are as follows. The original total of orchids listed for the Park at the beginning of our survey was 50 (Williamson 1981 *unpub.*). Two of these have recently been split into four new species, thus increasing Warrandyte's final tally. One particular species, Winter Greenhood *Pterostylis fischii*, has been placed on an unconfirmed list as Warrandyte is well outside its known range and this has led to questions regarding its identification and possible hybrid origin. Since the survey began, five taxa of orchid have been found that had not been recorded by anyone in the Park before. These are the following locally endangered species: Mayfly Orchid *Acianthus caudatus*, Fertile Caladenia *Caladenia prolata*, Red Beard-orchid naked peloric form *Calochilus paludosus*, Notched Onion-orchid *Microtis arenaria* and Red-tip Greenhood *Pterostylis* sp. aff. *parviflora* (one of the taxa resulting from the splits).

The current total number of orchid taxa recorded for the WSP is 67 (Table 1), nomenclature follows DNRE (1998) with the exception of *Pterostylis squamata*. which follows Bishop (1996). However, 20 of the orchid taxa have not been sighted

since 1990 (or earlier) and these are presumed to be locally extinct (Table 2). Ratings have been assigned to those species of orchid which have significance at a state level (DNRE, 1998) and at a regional and local level (Beardsell, C. *pers. comm.*) (Fig 2). In addition, all the orchids have been given a conservation status for the Park based on our present knowledge of their numbers and distribution (Fig 3).

Management

In 1994, Matthew Le Duc, then Ranger-in-Charge of WSP, proposed that a Flora Management Team be set up with the aim of preserving, protecting and enhancing the Park's flora. The team consisted of two Rangers and two members of FOWSP. One of the initial decisions made by the team was that the highest priority would be the protection of threatened flora. Management strategies for a number of threatened species, including orchids, were prepared. This involved identifying and alleviating existing threats by actions that were achievable (Coupar and Van Bockel 1995). We realised that if active measures were not taken, many species of orchid would ultimately be faced with local extinction.

One of the major threats to orchids in WSP comes from rabbits, which are abundant in the woodlands and in the riparian forest and the dry forest areas of the Park. There are also local pressures from macropods and possums through population imbalances which can be attributed to adjoining land settlement. To a lesser

Table 1. Orchids of Warrandyte State Park.

Acianthus caudatus	Mayfly Orchid
Acianthus pusillus	Small Mosquito Orchid
Arthrochilus huntianus	Elbow Orchid
Caladenia australis	Southern Spider-orchid
Caladenia caerulea	Blue Caladenia
Caladenia carnea	Pink Fingers
Caladenia catenata	White Caladenia
Caladenia clavigera	Plain-lip Spider-orchid
Caladenia deformis	Bluebeard Caladenia
Caladenia gracilis	Musky Caladenia
Caladenia iridescens	Bronze Caladenia
Caladenia lindleyana	Wine-lipped Spider-orchid
Caladenia menziesii	Hare Orchid
Caladenia parva	Small Spider-orchid
Caladenia phaeoclavia	Brown-clubbed Spider-orchid
Caladenia praecox	Early Caladenia
Caladenia prolata	Fertile Caladenia
Caladenia pusilla	Tiny Caladenia
Caladenia tentaculata	Mantis Orchid
Caladenia venusta	Large White Spider-orchid
Caleana major	Large Duck-orchid
Calochilus paludosus	Red Beard-orchid
Calochilus paludosus (naked peloric form)	Red Beard-orchid
Calochilus robertsonii	Purplish Beard-orchid
Chiloglottis reflexa	Autumn Bird-orchid
Chiloglottis valida	Common Bird-orchid
Corybas diemenicus	Veined Helmet-orchid
Corybas incurvus	Slaty Helmet-orchid
Cryptostylis leptochila	Small Tongue-orchid
Cryptostylis subulata	Large Tongue-orchid
Cyrtostylis reniformis	Small Gnat Orchid
Dipodium roseum	Rosy Hyacinth-orchid
Diuris corymbosa	Wallflower Orchid
Diuris lanceolata	Golden Moths
Diuris lanceolata X *pardina*	Hybrid Diuris
Diuris pardina	Leopard Orchid
Diuris sulphurea	Tiger Orchid
Eriochilus cucullatus	Parson's Bands
Gastrodia sesamoides	Cinnamon Bells
Genoplesium despectans	Sharp Midge-orchid
Glossodia major	Wax-lip Orchid
Lyperanthus suaveolens	Brown-beaks
Microtis arenaria	Notched Onion-orchid
Microtis parviflora	Slender Onion-orchid
Microtis unifolia	Common Onion-orchid
Prasophyllum brevilabre	Short-lip Leek-orchid
Prasophyllum odoratum	Scented Leek-orchid
Pterostylis alpina	Mountain Greenhood
Pterostylis concinna	Trim Greenhood
Pterostylis curta	Blunt Greenhood
Pterostylis longifolia	Tall Greenhood
Pterostylis nana	Dwarf Greenhood
Pterostylis nutans	Nodding Greenhood
Pterostylis parviflora	Tiny Greenhood
Pterostylis sp. aff. *parviflora*	Red-tip Greenhood
Pterostylis pedunculata	Maroonhood
Pterostylis plumosa	Bearded Greenhood
Pterostylis revoluta	Large Autumn Greenhood
Pterostylis squamata	Common Ruddyhood
Pyrorchis nigricans	Red-beaks
Thelymitra antennifera	Rabbit Ears
Thelymitra flexuosa	Twisted Sun-orchid
Thelymitra ixioides	Spotted Sun-orchid
Thelymitra media	Tall Sun-orchid
Thelymitra pauciflora	Slender Sun-orchid
Thelymitra rubra	Salmon Sun-orchid
Thelymitra X *truncata*	Hybrid Sun-orchid

Table 2. Orchids presumed to be extinct in Warrandyte State Park

Scientific Name	**Common Name**	**Source**	**Last Seen**
Arthrochilus huntianus	Elbow Orchid	AW	1978
Caladenia australis	Southern Spider-orchid	JRv	1980
Caladenia clavigera	Plain-lip Spider-orchid	Pp	1969
Caladenia deformis	Bluebeard Caladenia	CB	1975
Caladenia iridescens	Bronze Caladenia	AW	1968
Caladenia venusta	Large White Spider-orchid	JRv	1980
Caleana major	Large Duck-orchid	AW	1969
Corybas incurvus+	Slaty Helmet-orchid	Pp/SC	early 1980's
Cryptostylis leptochila	Small Tongue-orchid	AW	1961
Cryptostylis subulata	Large Tongue-orchid	AW/CB	1982
Cyrtostylis reniformis+	Small Gnat-orchid	AW/CB/Pp	1975
Gastrodia sesamoides	Cinnamon Bells	AW/KR	1969
Prasophyllum odoratum	Scented Leek-orchid	JRv	1975 – 1980
Pterostylis nana+	Dwarf Greenhood	AW/CB/JRv/Pp/JRd	1980
Pterostylis revoluta	Large Autumn Greenhood	CB/JRv/Pp/GJ	1989
Pyrorchis nigricans	Red-beaks	AW	1985
Thelymitra antennifera	Rabbit Ears	AW/CB	1975
Thelymitra flexuosa	Twisted Sun-orchid	AW/CB	1989
Thelymitra media	Tall Sun-orchid	AW/CB	1975
Thelymitra X truncata	Hybrid Sun-orchid	AW	1981

+recently reintroduced into WSP from Eltham
AW = Arthur Williamson; JRv = Josh Revell; Pp = Park Proposal; CB = Cam Beardsell;
JRd = John Reid; GJ = Glen Jameson; SC = Scott Coutts; KR = Kris Reinertsen

degree slugs, snails and millipedes also damage orchid populations, particularly Greenhoods (*Pterostylis* species).

In some areas, gregarious ground-feeding birds cause enormous problems, digging up whole populations of orchids in their search for food. A case in point is Rosella Spider-orchid *Caladenia rosella*, an endangered orchid statewide which is known from only four sites on the outskirts of Melbourne and a single plant from a reserve near Stawell (Backhouse and Jeanes 1995).

Between 1989 and 1991, 90% of the largest population of this orchid on private land at Cottles Bridge was dug up by White-winged Choughs. The number of these birds has increased between five and ten-fold over the last thirty years. This is due to a number of reasons. Increased settlement in the area has led to an increased interface between forest and cleared land - which is the bird's preferred habitat. The construction of farm dams has made available mud for nest building in dry gullies which were previously not used by the Choughs for breeding. Availability of supplementary food from local residents greatly increases the carrying capacity of the land in poor seasons and also encourages the birds into orchid-rich areas (C. Beardsell *pers. comm.*).

Another serious threat to the orchids is weed invasion. Weeds, particularly grasses, compete with orchids for light, moisture, space and nutrients, they also tend to encourage introduced slugs and snails. Many of the weed species have escaped from gardens adjacent to the Park either as wind-blown seed; carried in by birds, foxes or earth-moving machinery; or vegetatively for example Wandering Jew **Tradescantia albiflora*. Weeds are also introduced through unauthorised clearing and dumping of garden rubbish. Indigenous vegetation communities in the western part of the Park are under particular pressure from residential development (Warrandyte State Park Management Plan 1990).

During the course of the survey it became evident that a number of localised 'hot spots' occur in the Park – areas with a high number of orchid plants or a high diversity of species. This fact made management of the orchids a little easier.

In 1992 the first rabbit exclusion fence was built (approximately 50 m by 50 m) around an identified 'hot spot' on Fourth Hill. Since then, six similar fences have been constructed in other areas of the Park. The most recent of these was built in May 1997 at The Common in an area known to have a high density of orchid species ten years ago. Like the other plots, this one will be weeded and responses in orchid populations (anticipated to be positive) will be systematically monitored. These

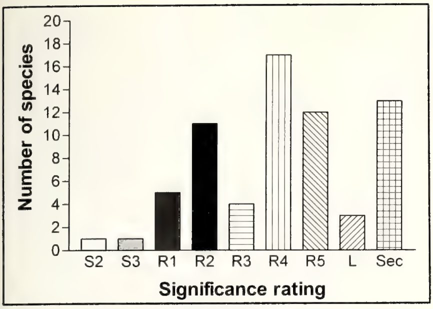

Fig. 2. Significance ratings for Warrandyte's orchids.
State: *S2* vulnerable in Victoria; *S3* rare in Victoria. **Regional:** ***R1*** endangered in Greater Melbourne; ***R2*** vulnerable in Greater Melbourne; ***R3*** rare in Greater Melbourne; ***R4*** depleted in Greater Melbourne; ***R5*** restricted in Greater Melbourne. **Local:** ***L*** significant in the Warrandyte district. **Secure (Sec)** not listed by DNRE (1998) or Cam Beardsell (*pers comm*) as being significant in the state, region or district.

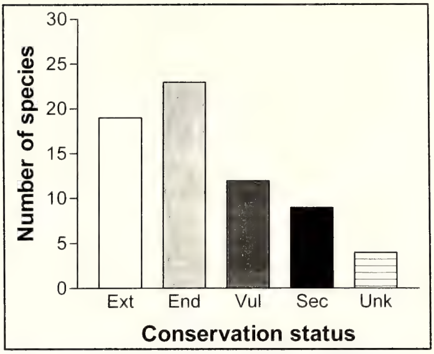

Fig. 3. Conservation status of orchids in Warrandyte State Park.
Extinct (Ext), not seen since 1990, presumed extinct; ***Endangered (End)***, endangered of becoming extinct within the next 10 to 20 years; ***Vulnerable (Vul)***, vulnerable of becoming endangered within the next 10 to 20 years; ***Secure (Sec)***, not considered to be threatened; ***Unknown (Unk)***, species has been difficult to identify confidently and therefore to map its distribution.

fences are constructed with steel star pickets and wire netting to a height of at least 80 cm, they are fire proof and have an estimated life span of 20–30 years. Some have been built with the assistance of the FOWSP who, on two occasions obtained grants from the then 'Melbourne Parks and Waterways' for fencing materials.

The two most successful exclusion fences built for orchid conservation are the original one on Fourth Hill (FH1), which was enlarged in June 1997 from 0.25 ha to about 0.8 ha and one of similar size at Timber Reserve (TR). The latter was constructed in 1993 by FOWSP and Park staff over several months.

Since October 1994, these two fences, and one other on Fourth Hill (FH2), have been systematically hand weeded each spring. The major weed species in all three fences are Large Quaking-grass **Briza maxima* and Sweet Vernal Grass **Anthoxanthum odoratum*. The results of the hand weeding are most encouraging with an estimated 80% reduction of these exotic grasses over the three years (Coupar and Willis 1997 *unpub.*). In October and November 1996 a buffer of about five m was weeded around the outside of each of the three fences. It is planned that this buffer will be extended each year.

Prior to the first weeding in 1994, a list was compiled of all plant species found inside the fences. Each year new species have been found and added to the list. The additional orchids seen in 1995 and 1996 were most likely present in 1994, but not observable due to the history of rabbit grazing and unfavourable growing conditions. The graph (Fig 4) indicates how orchid species numbers have increased over a three year period following construction of the exclusion fences. The response by the orchids has been dramatic and can be termed the 'establishment stage', where each species responds favourably to the removal of the threatening factors. When all available niches have been filled, it is expected that a 'maintenance stage' will be reached where some species will plateau out while others may decline. Management strategies may need to be reviewed during the maintenance stage.

Since the majority (80%) of Warrandyte's orchid flora are threatened with local extinction over the next several decades, species have been prioritised in order of significance for management purposes. Only two orchids have State significance. These are: the Large White spider-orchid *Caladenia venusta* rated as 'rare' in Victoria, which has not been seen in the Park since about 1980 and is presumed extinct, and the Wine-lipped Spider-orchid *Caladenia lindleyana* rated as 'vulnerable' in Victoria which was rediscovered in the Park in October 1995 (Fig. 5). *Caladenia lindleyana* was one of the new records for the original Fourth Hill

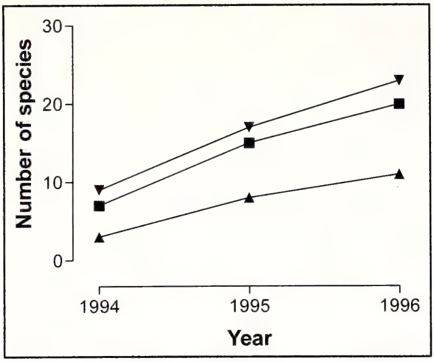

Fig. 4. Increases in orchid species in the fences (■ FH1, ▲ FH2, ▼ TR) over three years.

fenced site (FH1), with one flower observed a year after its construction. Since then several small populations of this orchid have been found in other areas of the park and on nearby private property. All populations are being monitored annually.

In November 1996, to increase the success of this species in setting seed, 15 plants from six populations were cross-pollinated by hand on advice from local botanist Cam Beardsell. He had observed diminishing levels of natural pollination events in populations right across Melbourne's north-east foothills. Of the eight plants checked six weeks later, seven of them (88%) had produced a fruiting capsule. So far, hand pollination has only been carried out on one other species, Bearded Greenhood *Pterostylis plumosa* a regionally endangered orchid. Botanist Geoff Carr recommended hand pollination in this case, and the results appear to be most encouraging, with an approximate 58% of plants (seven out of 12) that were hand pollinated, setting seed. Hand pollination, however, is a 'manipulative technique' used as an interim measure while further investigation is being carried out into the cause of poor natural pollination.

Other management strategies for orchid conservation have included an ecological burn at Fourth Hill prior to the construction of fence FH2. Two years following this fire a small population of Brown-beaks *Lyperanthus suaveolens* appeared in an area where, despite intensive surveys, they had not been seen for over 10 years. This remains the only known population of this orchid in the Park.

Fig. 5. Wine-lipped Spider-orchid *Caladenia lindleyana.*

In 1987, approximately 1000 orchid tubers were removed from an area of bushland in Eltham that was about to be subdivided, and transplanted into the Park at three locations in Black Flat. The species were Small Spider-orchid *Caladenia parva* or Brown-clubbed Spider-orchid *C. phaeoclavia*, Pink Fingers *C. carnea*, Slaty Helmet-orchid *Corybas incurvus*, Parson's Bands *Eriochilus cucullatus*, Wax-lip Orchid *Glossodia major*, Trim Greenhood *Pterostylis concinna*, Blunt Greenhood *P. curta*, Tall Greenhood *P. longifolia*, Nodding Greenhood *P. nutans* and Common Ruddyhood *P.squamata*. Although the sites were marked on a map and accompanied by a list of species transplanted, no detailed monitoring of the orchids was carried out. However, Slaty Helmet-orchid *Corybas incurvus* presumed extinct in previously known locations in the Park, has been found in flower at the transplant site. It appears that most of the other transplants have failed to survive.

Translocation trials are currently being carried out under a permit from the Department of Natural Resources and Environment in accordance with the Flora and Fauna Guarantee Act 1988 (Parliament

of Victoria, 1988). The intention is to re-establish populations within the park, of a selection of locally extinct species. Following the requirements under the permit, a search for propagating material is carried out firstly on private land, secondly on Crown land and lastly on land reserved under the National Parks Act. Tubers and/or seed are only collected from sites where that species is considered secure. Nodding Greenhood *Pterostylis nutans*, a common species in the Park, was trialled first to validate the technique. In 1995 and 1996, Trim Greenhood *P. concinna*, Dwarf Greenhood *P. nana* and Small Gnat-orchid *Cyrtostylis reniformis* were collected with soil while actively growing, from an Eltham Reserve. The orchids were transplanted into site FH2 and will be monitored carefully over the next few years.

Future

There is no doubt that Rangers, 'Friends' and local orchid enthusiasts will continue to search for those elusive orchid species that are presently presumed extinct in the Park, and while doing so may discover new species records for the Park or find new localities of locally threatened species.

A great concern is that so many of Warrandyte's orchids occur in such small numbers. Future management, aimed at increasing the germination of specific orchids, may include inoculation of the soil with appropriate mycorrhizal fungi prior to seed set - a technique, recommended by Simon Cropper (botanical consultant). In addition, we are investigating the use of 'smoke water'. This technique, developed in Western Australia and also recommended by Simon Cropper involves spraying the ground with water treated with smoke to encourage germination of indigenous seeds in the soil.

Despite the release of the Rabbit Calicivirus in 1996, rabbit numbers have not been significantly reduced. However, during the summer of 1998 a 'Rabbit Busters Program' substantially reduced rabbit numbers in three areas of the State Park and with good autumn rainfall it is hoped that orchids will respond favourably.

Yearly monitoring of all locally endangered species is an ongoing commitment by the Park staff. Already we have seen the benefit of excluding rabbits and intensive hand weeding, and for some species the future is certainly more promising than it was six years ago when this study began.

Early in 1998 FOWSP received their third grant from Parks Victoria (previously Melbourne Parks and Waterways grants program). The money will be used to extend the highly successful rabbit exclusion fence at Timber Reserve in order to include a small population of the Wine-lipped Spider-orchid *Caladenia lindleyana* that was rediscovered in 1996.

Acknowledgements

Firstly we would like to thank Melanie Coupar for her line drawing of the Wine-lipped Spider-orchid. Much knowledge of Warrandyte's orchid flora has been gained over the past six years and we are deeply indebted to many people for their assistance. We would particularly like to thank naturalist, Arthur Williamson, for sharing his experiences with us, much of our current plant list is based on his original list of the WSP flora and without it our study would have been so much more difficult. We received invaluable assistance from botanist Cam Beardsell, who has expertise on the orchid flora of Greater Melbourne and was so willing to share that knowledge with us. Botanist's David Cameron and Graeme Lorimer have always been on hand when we needed them. Jeff Jeanes, botanist at the Melbourne Herbarium, and Geoff Carr have both provided valuable information and advice. Finally we are indebted to the local residents, especially Josh Revell and other orchid 'devotees' who have contributed, not only their knowledge, but their enthusiasm and love of orchids.

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The Discovery of the Mountain Pygmy-possum *Burramys parvus* on Mount Buller, Victoria

Dean Heinze[1] and Lance Williams[2]

Abstract

In 1995 the remains of a Mountain Pygmy-possum were found in a fox scat near Mount Stirling. In the following year potential habitat at Mount Buller and Mount Stirling was trapped and *B. parvus* was detected at Mount Buller. The *B. parvus* population in Victoria consists of four known sub-populations, where the Mount Buller sub-population is the southern-most colony and is relatively isolated. (*The Victorian Naturalist*, **115(4)**, 1998, 132-134).

Introduction

The Mountain Pygmy-possum *Burramys parvus* is the only Australian mammal restricted to the alpine and sub-alpine areas. It is endemic to Victoria and New South Wales (Mansergh 1984; Caughley 1986). *Burramys parvus* appears to have very specific habitat requirements, of which there are two components: (i) periglacial boulder streams/rock screes, and (ii) associated vegetation communities, the most distinctive being the Mountain Plum Pine *Podocarpus lawrencei* heathland (Gullan and Norris 1984; Mansergh *et al.* 1989). In Victoria the known distribution of *B. parvus* includes three distinct areas - Mount Higginbotham to Mount Loch, the Bogong High Plains and Mount Bogong. Since each area is isolated by low altitude valleys below 1200 m the Victorian *B. parvus* population is regarded as having three sub-populations (Mansergh *et al.* 1989; Mansergh and Broome 1994).

Background

In April and May 1995 Biosis Research Pty. Ltd. conducted a fauna survey of Mount Stirling as part of the Mount Stirling Environmental Effects Statement (EES). Analysis of a canine scat collected on the lower slopes of Mount Stirling revealed *B. parvus* remains, most notably the enlarged serrated premolar tooth peculiar to the species (refer to Mansergh and Broome 1994). As the closest known *B. parvus* colony was at Mount Hotham, 60 km away, this evidence suggested that a colony existed in the Mount Stirling-Mount Buller area (Fig. 1).

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In November 1995 Biosis conducted further survey work on Mount Stirling as part of the EES. Stanley's Bowl, although having been trapped on at least two previous occasions (by C. Meredith in 1973 and M. McFarlane in 1983) with no captures of *B. parvus*, was identified as the area of most suitable *B. parvus* habitat on Mount Stirling, and 100 Elliot traps were set there for a total of 400 trapnights. However, only the Bush Rat *Rattus fuscipes* and Dusky Antechinus *Antechinus swainsonii* were trapped.

In February 1996 the (then) Department of Conservation and Natural Resources (DCNR) also trapped at Stanley's Bowl for 50 trapnights. Again only Bush Rat and Dusky Antechinus were trapped. In that same month DCNR also set traps on Mount Buller.

Mount Buller

Trapping at Mount Buller on 20–28 February 1996 resulted in the capture of eight *B. parvus* individuals (Table 1), comprising six juvenile females (Fig. 2), one juvenile male and one adult female.

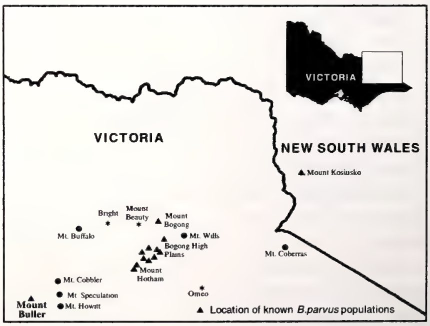

Fig. 1. Known locations of Mountain Pygmy-possum *Burramys parvus* since 1966.

Fig. 2. A female juvenile *Burramys parvus* caught from the Federation area, Mount Buller. Photo: Freddie Mercay.

Table 1. Summary of *Burramys parvus* trapping at Mount Buller.

Area	Trapnights	*B. parvus* captures	Trapping success	Non target species*
Federation ski slopes	260	4#	1.9	103
Mt. Buller - south summit	440	4	0.9	164
Mt. Buller - north summit	120	0	0	35
Mt. Buller Total	**820**	**8#**	**1.1**	**302**

* Bush Rat, Dusky Antechinus, and Agile Antechinus.
\# One individual was captured on two separate occasions.

All animals appeared to be healthy, falling within the weight range of 24–35 g. Hair samples were collected from each animal as part of genetic research into the species that is being carried out at LaTrobe University. Other mammal species trapped included *R. fuscipes, A. swainsonii* and the Agile Antechinus *A. agilis* (previously Brown Antechinus *A. stuartii*: see Dickman *et al.* 1998; Sumner and Dickman 1998). Subsequent trapping has revealed a *Burramys* population of approximately 300 breeding animals (D. Heinze *unpubl. data*).

Approximately 20.3 ha of *B. parvus* habitat occurs on Mount Buller, including three distinct patches: Mount Buller South summit - 6.2 ha; Mount Buller North summit - 7.8 ha and Federation ski slopes - 6.2 ha (refer to Fig. 3). Habitat occurs at altitudes from 1300–1700 m. The rock scree at Federation is a mixture of granite and basalt boulders, whereas the Mount Buller summit area consists of boulders of a sedimentary origin. These screes/boulders are unstable and often slip when walked upon.

All of the habitat is located within the Mount Buller Alpine Resort. *Burramys parvus* habitat at the Federation Ski Run has been modified by the removal of vegetation, blasting of boulders, burial of rock

scree, and the construction of maintenance roads. Habitat surrounding the Mount Buller Summit appears not to be modified by ski resort infrastructure.

Discussion

With the additional discovery of *B. parvus* on Mount Buller, the Victorian population can be regarded as being made up of four sub-populations. However, it is possible that further populations could exist at other locations that have hitherto been overlooked for intensive surveys, e.g. Mount Speculation and The Cobberas. Based on our current knowledge of the species' distribution, the Mount Buller *B. parvus* population is the most isolated colony.

Results from further trapping on Mount Buller suggest it has a small population, with relatively little suitable habitat available. Mount Stirling, which adjoins Mount Buller, also appears to have very little suitable habitat. The only available habitat on Mt. Stirling consists of granite boulder outcrops near the summit (Stanley's Bowl). Similar outcrops elsewhere contain few, if any, *B. parvus* individuals, e.g. Mount McKay and The Niggerheads (Mansergh *et al.* 1989; Heinze 1995; D. Heinze *pers. obs.*).

Mount Buller is intensively utilised for recreation purposes and, as a result, many areas of *B. parvus* habitat have been modified. While the effect of such change is yet to be determined, the example of Mount Hotham (Mansergh *et al.* 1989) shows that the dispersal and migration patterns may have been affected, and the degradation of habitat may be prevalent.

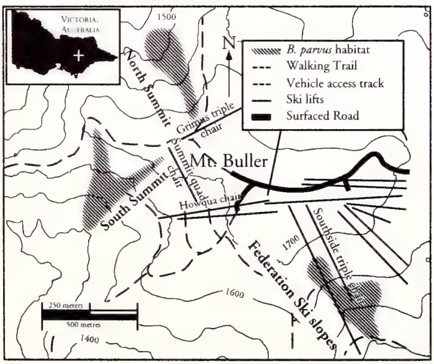

Fig. 3. *Burramys parvus* habitat and trapping sites at Mount Buller.

The Mount Buller *B. parvus* population is certainly unique. Research by the Department of Natural Resources and Environment and LaTrobe University will continue in the future to establish the population biology and dynamics, and will provide data comparable with that which has, or is being carried out on the other sub-populations (Mansergh and Broome 1994; Heinze 1995; DNRE and LaTrobe University, ongoing research).

Acknowledgements

Dean Heinze would like to thank many DNRE staff - in particular Ian Mansergh, Mat White and Glen Johnson for their valuable advice and field support; Sandy Jefcott (Alpine Resorts Commission) for organising accommodation, field support and providing survey information; Daryl Rowe for designing the maps; and to William Zormann who assisted with field work. Lance Williams would like to thank Sid Larwill and Charles Meredith (Biosis Research), and Micheal Scroggie and Emma Moysey for field assistance, and Barbara Triggs for scat and hair analysis. Research by Dean Heinze was funded by the Flora and Fauna Branch, Natural Resources and Environment (short term contract).

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Identification of Squirrel Gliders and Sugar Gliders in Victoria

B.J. Traill[1]

Abstract

The Squirrel Glider *Petaurus norfolcensis* is a threatened gliding possum found in Box-Ironbark forests and woodlands of Victoria. In the field the Squirrel Glider can be difficult to positively identify because it is similar to the closely related Sugar Glider *Petaurus breviceps*. The currently available guides on native mammals fail to clearly list the diagnostic features of the two species. This paper lists and discusses the key diagnostic features which can be used to identify the two species in the field. (*The Victorian Naturalist* **115(4)**, 1998, 135-141).

Introduction

The Squirrel Glider *Petaurus norfolcensis*, is a small (<350 g) gliding possum. It is one of a large number of threatened vertebrates found in the temperate woodlands and forests of inland Victoria, New South Wales and Queensland (ESP 1992; DNRE 1995; Robinson and Traill 1996). In Victoria, Squirrel Gliders are restricted to parts of central and northern Victoria (Menkhorst 1995).

Over the last several years there has been an increased interest from conservationists, naturalists and biologists in the conservation of the Squirrel Glider and a number of other threatened species in the drier forests and woodlands inland of the Great Dividing Range. Consequently, there has been an increase in biological surveys done in these regions by both professional biologists and amateur naturalists (eg. Alexander 1997; Myers 1997; Robinson and Mann 1996; Soderquist *et al.* 1996).

In the field the Squirrel Glider can be difficult to identify because it resembles the closely related Sugar Glider *Petaurus breviceps*. The Squirrel Glider is larger than the Sugar Glider but the two species have otherwise quite similar morphologies. They also have similar behaviour patterns and diets (Menkhorst *et al.* 1988; Quin 1995; Traill 1995). The Sugar Glider is more widespread and abundant than the Squirrel Glider and occurs in most types of eucalypt forest and woodlands throughout eastern Australia (Menkhorst 1995). The range of the Squirrel Glider is more restricted and lies totally within the broader range of the Sugar Glider. In regions where both species occur the two species coexist at many sites (eg. Quin 1995; Traill 1995).

Problems in separating the two gliders in the field have not been helped by the available mammal field guides and commonly available texts. These fail to explain clearly how to distinguish the two species. This note sets out the features that can be used to positively distinguish Squirrel Gliders from Sugar Gliders in the field. I based the guide on observations I made during a study of the two species over five years at Chiltern in north-east Victoria (Traill 1995) and other observations made during shorter periods of survey work throughout central and western Victoria. It also incorporates some of the observations of other observers, especially Lyndall Rowley, John Robinson, Jerry Alexander and Rodney Van der Ree. This guide is based on information from Victorian populations so may not be relevant for populations in other states. Rather than attempting to give a full description of each species, I simply describe the diagnostic features of each species that can be used in the field. These include the different calls of the two species, diagnostic features that can be observed while spotlighting, and identification of live animals in the hand that have been trapped or captured from nest-boxes. Full descriptions of the morphologies of the two species can be found in Smith (1973, 1979), Hyett and Shaw (1980) and Suckling (1995). Information useful for the identification of skeletons or individual bones can be found in Alexander (1981).

To help clarify where Squirrel Gliders are now known to occur, I have included some additional information on the

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known habitats and distribution of the species in Victoria.

Identification by sight while spotlighting
Tail colour

Some Sugar Gliders have tail-tips with completely white fur, while Squirrel Gliders have never been recorded with a tail-tip of completely white fur. When present on Sugar Gliders this white tail-tip contrasts strongly against the black and grey of the rest of the tail. The extent of the white can vary from the last few centimetres being white to the last few hairs on the tail-tip being white. At Chiltern 28 of the 82 Sugar Gliders captured (35%) had a white tail-tip (*pers. obs.*). Alexander (1981) examined museum skins from throughout Australia and found that 44 of the 68 Sugar Gliders examined had a white tail-tip (66%). Thus, the percentage with white tail-tips may vary somewhat between populations but it appears that all Victorian populations of Sugar Gliders have a significant proportion of individuals with a white tail-tip (*pers. obs.*). If an animal has a white tail-tip, usually it can be seen clearly when spotlighting. This feature can only be used to positively identify some Sugar Gliders. An animal with a completely black tail can be either a Sugar Glider or Squirrel Glider.

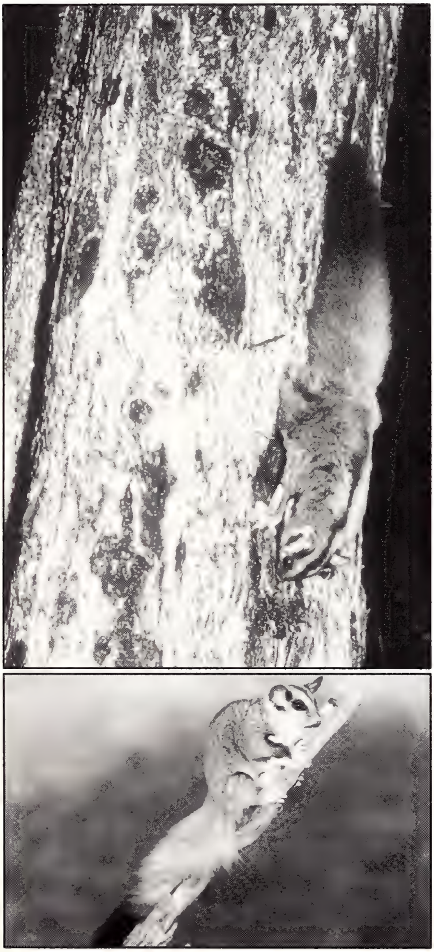

Fig. 1. Squirrel Glider.

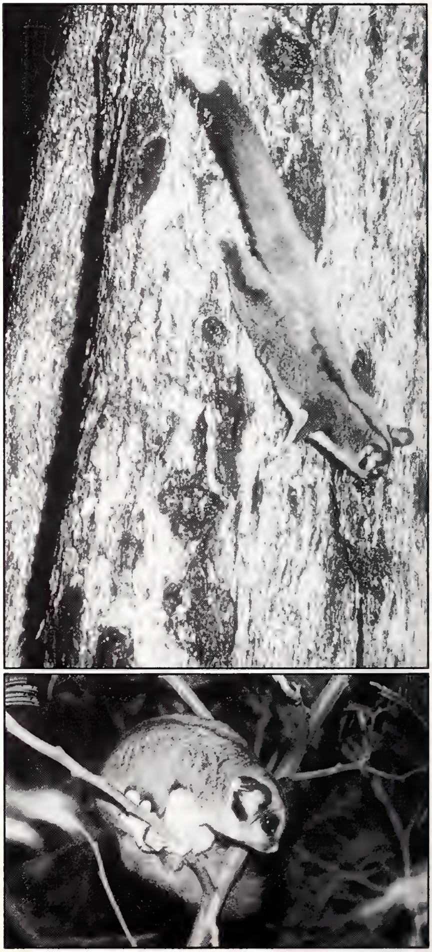

Fig. 2. Sugar Glider.

If an animal has a black tail, identification when spotlighting relies on three other features: the facial features, the tail width, and the size of the animal. However, all of these can only be judged subjectively when the animal is not in the hand. Each of these features is discussed separately.

Facial features

In comparison with a Sugar Glider, the snout of Squirrel Gliders is longer and more pointed (Quin *et al.* 1996) and the ears appear to be more prominent. In contrast, Sugar Gliders have a distinctly snub-nosed look with a rounded, blunt, head profile (Figs. 1 and 2). This difference between the two species is distinctive and consistent in adult animals. If the glider's head can be clearly observed, it is a reliable diagnostic feature when spotlighting. However, as the feature can only be judged subjectively when spotlighting, observers need to have extensive experience of observing at least one of the two species before making an identification based on this feature.

Tail width

The tail of a Squirrel Glider is more 'bushy' than a Sugar Glider. For much of its length Squirrel Glider tails are distinctly wider than the base of their bodies. In contrast Sugar Glider tails are only as wide, or just wider, than the body width at the base of the tail (Figs. 1 and 2). The tail also rapidly tapers to a narrower width which is consistently much narrower throughout its length in comparison with that of a Squirrel Glider. As with facial features, this difference between the two species is distinctive and consistent in adult animals. Juvenile Squirrel Gliders which are not yet independent may have tails which are not 'bushy'. If the tail can be clearly observed this is a reliable diagnostic feature when spotlighting. However, this feature can only be judged subjectively when spotlighting. To use tail-width as a diagnostic feature observers need to have extensive experience of observing at least one of the two gliders.

Size

In Victoria, adult Squirrel Gliders are on average nearly twice the weight of adult Sugar Gliders, and considerably longer in body and tail length (Alexander 1981; Traill 1995). I have found that judging the size of a glider a short distance away is accurate as a diagnostic feature for distinguishing large Squirrel Gliders and small Sugar Gliders.

Weights of the different species are discussed later in this paper. I did not record body or tail lengths during my studies. For pickled specimens from Victoria, Alexander (1981) recorded adult Sugar Gliders as having an average nose to vent length of 154.0 mm (35 specimens) and vent to tail-tip length of 193.2 mm (37 specimens). He recorded Squirrel Gliders with nose to vent lengths of 167 mm and 220 mm (two specimens) and vent to tail-tip lengths of 250–279 mm (four specimens). For records from throughout Australia, Suckling (1995) recorded Sugar Glider combined head and body lengths of 160–210 mm (mean 170 mm) and tail lengths of 165–210mm (mean 190mm). He recorded Squirrel Gliders as having a head and body length of 180–230 mm (mean 210 mm) and a tail length of 220–300 mm (mean 270 mm). Note that Suckling's figures indicate the potential for overlap in the absolute lengths of large adult Sugar Gliders and small adult Squirrel Gliders. There will also be overlap in length between adult Sugar Gliders and immature Squirrel Gliders.

Even when seeing adult animals, differences in size are difficult to judge accurately by eye, especially when spotlighting. Accurate judgement of size is highly dependent on the experience of the observer and their familiarity with both glider species. Therefore, size can only be used with great caution as a diagnostic feature when spotlighting. It is useful only with some individuals of both species and should only be used as a diagnostic aid by observers who have had extensive experience of observing both of the gliders.

There is considerable variation in the size of both glider species throughout Australia so *size may not be useful as an identification feature outside Victoria.* For example in south-east Queensland, Squirrel Gliders are very similar in size to Sugar Gliders (C. Rishworth *pers. comm.*).

Identification by call

Of the two species, only Sugar Gliders regularly call outside the nesting hollow. The most commonly heard Sugar Glider call is a soft ventriloquial 'wuk' or 'yap' which is reminiscent of a small dog yapping in the distance. This call appears to function as a warning alarm and is often heard when an animal is disturbed by a night bird or by spotlighting. The presence of yapping Sugar Gliders in an area does not indicate that only Sugar Gliders are present, as the two species coexist at many sites.

Both gliders infrequently give a throaty gurgle/shriek when under direct threat, such as when being handled by humans or when fighting with other gliders. Such calls can be sometimes heard in nest trees before animals emerge from hollows, and by animals fighting in trees at food sources. I cannot distinguish any difference between the two species giving this type of call.

In addition to the 'throaty gurgle' call, Squirrel Gliders have been heard very rarely to give other calls (P. Peake *pers. comm.;* D. Quin *pers. comm.*; *pers. obs.*). To date there is no consistency in the description of these calls and they cannot be used as a basis for identification of Squirrel Gliders from Sugar Gliders.

Identification in the hand

All the diagnostic features noted above can be used in identifying captured animals. However, with the exception of size and tail colour, the features are subjectively judged. Size and tail colour are, therefore, the best features for identifying in the hand. Due to the difference in weight between Victorian Squirrel Gliders and Sugar Gliders, identification of adult animals in the hand is usually simple, if the animal can be weighed. Table 1 gives the mean weights of adult animals from Chiltern. With an average adult weight of 249.5 g for males, and 220.5 g for females, adult Squirrel Gliders are nearly twice the weight of Sugar Gliders (males 129.7 g; females 115.3 g) and there is no overlap in the weights of adult animals at this site. Weights from elsewhere in Victoria indicate that there are variations in weight of this magnitude throughout the state (Traill *unpub. data*; R. Van der Ree *pers. comm.*).

Table 1. Weights of adult Squirrel Gliders and Sugar Gliders at Chiltern. Key: A, average weight (g) ± standard deviation; N, number of animals; R, range of weights (g).

	A	N	R
Squirrel Glider			
Male	249.5 (±22.5)	44	192-306
Female	220.5 (±19.9)	30	187-294
Sugar Glider			
Male	129.7 (±11.9)	17	115-150
Female	115.3 (±11.4)	13	89-139

There is potential overlap in weights of immature* Squirrel Gliders and adult Sugar Gliders. The smallest immature Squirrel Glider I have trapped or found alone in a nest-box was 81 g. I have made eleven other captures of Squirrel Gliders between 100–150 g in weight.

Such immature gliders can be separated by examining the tail colour, tail width and facial features. As an additional aid, the age of the glider can be estimated by examining the amount of tooth wear on the animal. Data from Chiltern indicate that all Sugar Gliders of >100 g in weight will be more than 12 months of age. Conversely, Squirrel Gliders of less than 150 g weight will be less than 12 months old (Traill 1995).

Determining the age of animals is done by examination of the two upper incisors. In both species, the upper incisors progressively wear as the animal ages. Immature animals which have only recently become independent have no wear on their front upper incisors, giving a more 'buck-toothed' look. As a glider ages the incisors become progressively more worn, with eventually no gap occurring between the two teeth, and with the enamel clearly worn away from the cutting edge. If any distinct wear is apparent, the animal is at least 12 months old and is likely to be at, or very close to, its full body weight. If the glider is held securely in the hand, examination of the teeth can be done quickly and easily with minimal additional stress to the glider. The patterns of teeth-wear are described in more detail in Suckling (1984).

* Immature refers in this paper to animals which are leaving the nest independently at night but which are less than a year old.

Table 2. Comparison of diagnostic features of Sugar Gliders and Squirrel Gliders in Victoria. See text for further details.

	Weight (adult)	Tail tip	Facial features	Tail width	Distinctive call
Squirrel Glider	>180g	black	pointed	wide	None known
Sugar Glider	80-150g	black or white	blunt	narrow	'yap'

Juvenile gliders** of less than 40 g are difficult to identify. However, when these are found in nest-boxes, the mother and other adults are almost invariably present with the juvenile. Sugar Gliders and Squirrel Gliders have never been recorded nesting together in the same tree hollow or nest-box. The juveniles will, therefore, be of the same species as the adults present. In a situation where a juvenile glider was somehow found alone, an identification could possibly be made by taking body and limb measurements, and comparing them with the growth stages for the juveniles of the two species as described in Smith (1979).

Other features which are not useful in identification

Belly fur colour

Squirrel Gliders generally have paler belly fur than Sugar Gliders (Alexander 1981). This appears to be used as an identification guide by many observers (*pers. obs.*). However, some Sugar Gliders, especially immature animals, have white or cream coloured belly fur, and some older Squirrel Gliders have yellowish fur on their bellies (*pers. obs.*). Furthermore, colours are often distorted when seen with a spotlight. I have found that Sugar Gliders with pale grey belly fur (noted after capture in daylight) can appear to have pure white fur when seen under artificial light at night. This feature should, therefore, not be used as a basis for identification.

Black markings

Squirrel Gliders typically have more distinct black facial and body stripes than Sugar Gliders (Alexander 1981; Suckling 1995; *pers. obs.*). However, these features vary considerably between individuals within both species. I did not find it possible to judge, in any useful way, the intensity of facial and body stripes, either when spotlighting, or in the hand.

Size of molars

It has been reported that Squirrel Gliders have molar teeth which are disproportionately larger than Sugar Gliders (Suckling 1995). This appears to be incorrect (Alexander 1981; *pers. obs.*).

Summary of identification features

- A Sugar Glider making a 'yap' call can be positively identified.
- A Sugar Glider with a white tail-tip can be positively identified by sight while spotlighting, or in the hand.
- In the hand, adults and immature animals of both species can be readily separated by weight, and if necessary, assessment of the age of the animal by examining the amount of tooth-wear.
- Whilst spotlighting only the subjectively judged facial features, tail-width and size can be reliably used to distinguish between the two species.
- Juveniles may be difficult to identify but are typically found with their parents in nests.

These diagnostic features of the two gliders are summarised in Table 2.

Distribution and habitat use of Squirrel Gliders

The map in Fig. 3 shows the current known range of Squirrel Gliders in Victoria. This species is restricted to parts of central and northern Victoria and within these regions are currently known only from the following habitats or areas that are closely adjacent to them.

1. Some forests and remnants of River Red Gum *Eucalyptus camaldulensis*. This includes some smaller remnants along roadsides and creeksides. Generally where

** Juvenile refers to animals which are not yet leaving the nest independently of their mother.

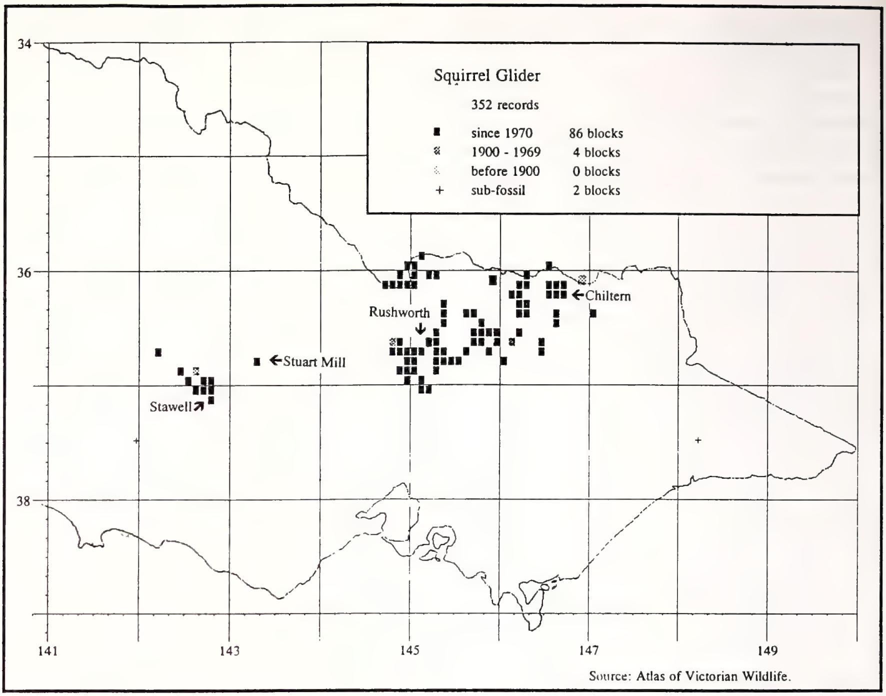

Fig. 3. Distribution of the Squirrel Gilder in Victoria.

Squirrel Gliders do occur in Red Gum forests, they are found in areas with some larger wattles (Black Wattle *Acacia mearnsii*, Silver Wattle *A. dealbata*, Golden Wattle *A. pycnantha*) in the understorey (Menkhorst *et al.* 1988; L. Rowley *pers. comm.*). Gum exuding from these wattles provides a key winter food source. Examples of this habitat are along the lower Goulburn and Ovens Rivers, in parts of Barmah Forest on the Murray River and along roadsides around Reedy Lake near Nagambie.

2. Grey Box *E. microcarpa*, Yellow Box *E. melliodora* and White Box *E. albens* forests and remnants on plains and low rises which have relatively fertile soils. In this habitat Squirrel Gliders typically occur in areas which have larger wattles in the understorey, as occurs in Red Gum (Gibbons 1980; Lane and Traill 1988; Traill 1995; R. Van der Ree *pers. comm.*). Examples of this habitat occupied by Squirrel Gliders are the roadsides in the plains between Euroa and Rushworth, and remnants near Stawell and Colbinabbin.

3. Forests of Mugga Ironbark *E. sideroxylon,* on poor gravel soils in north-eastern Victoria. The only occurrences of these forests in Victoria are in and around the Killawarra State Forest, the Chiltern National Park and some remnants in farmland near Benalla (Costermans 1994; *pers. obs.*). Squirrel Gliders in these forests feed extensively on Mugga Ironbark nectar in winter (Traill 1995).

In some areas the three habitats grade into each other.

It is important to note that Squirrel Gliders have not been recorded within the extensive Red Ironbark *E. tricarpa*, forests of central Victoria. Although there have been intensive surveys in many of these forests (Alexander 1997; Menkhorst and Gilmore 1979; Lane and Traill 1988; Soderquist *et al.* 1996; Myers 1997), it appears that Squirrel Gliders are absent from forests of Red Ironbark, or are present only on the fringes of this forest type. Possibly Red Ironbark is a less prolific nectar producer than the very similar Mugga Ironbark.

One puzzling feature of the distribution of Squirrel Gliders in Victoria is the gap in the known populations between Colbinabbin and Stawell. A number of surveys specifically for Squirrel Gliders in this region have failed to find any (J. Robinson *pers. comm.*; Alexander 1997) despite relatively large areas of apparently suitable Red Gum, Yellow Box and Grey Box habitat. However, The Victorian Wildlife Atlas records an observation of a Squirrel Glider from within this gap. This was a sight record of one glider made during spotlighting in 1983 at Wattle Flat, near Stuart Mill, south of St. Arnaud. There have been no further sightings at this specific site nor in nearby districts despite several specific searches (J. Robinson *pers. comm.*; Alexander 1997). Given the lack of corroborating observations the 1983 record should be regarded as doubtful unless further definite observations are made.

Acknowledgements

My thanks to Jerry Alexander, Lindy Lumsden, Paul Peake, Darren Quin, Coral Rishworth, John Robinson, Lindall Rowley, Joy Sloan, and Rodney Van der Ree for their discussions with me on the nuances of glider identification. Thanks also to Jerry Alexander, Susie Duncan and Rodney Van der Ree for comments on drafts and to Graeme Suckling and Freddie Mercay for providing photos.

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Sword-grass Brown Butterfly Project

Maria Belvedere[1], Greg Bain[1]
and Peter Steller[1]

Abstract

The Sword-grass Brown Butterfly Project (SBBP) is a community driven project initiated by the Knox Environment Society. We are planting habitat at sites between known populations of the butterflies in the hope of increasing their numbers. Project activities include revegetation and propagation, community art, monitoring and translocation. SBBP is also raising public awareness of the needs of Sword-grass Brown Butterfly and other butterfly species within The Basin-Boronia area. *The Victorian Naturalist*, **115 (4)**, 1998, 142-145).

Introduction

The Sword-grass Brown Butterfly Project was initiated in 1993 by members of the Knox Environment Society (K.E.S.) who were interested in the conservation of this locally significant and attractive butterfly species. State and local government agencies, schools, business and community groups have subsequently come to support the project. The Sword-grass Brown Butterfly, *Tisiphone abeona albifascia*, is under threat in the City of Knox because of loss of habitat containing Red-fruited Saw-sedge, *Gahnia sieberiana,* the larval food plant of the insect. This butterfly is known to occur in four bushland reserves within the municipality.

The Sword-grass Brown Butterfly, and the Red-fruited Saw-sedge understorey habitat it lives within, is now uncommon in most urban areas of Melbourne, including the City of Knox. The aim of the project is to increase habitat for this butterfly in the vicinity of existing populations within The Basin-Boronia area, specifically between Old Joes Creek Retarding Basin and Wicks Reserve. It also aims to increase the profile of this butterfly and local butterfly conservation in general.

The Sword -grass Brown Butterfly and Red-fruited Saw-sedge

Before we begin to describe the activities of the Sword-grass Brown Butterfly Project we will give a brief description of the butterfly which has inspired this project. The Sword-grass Brown Butterfly (Fig. 1) is an attractive chocolate brown butterfly with orange markings, a blue eyespot on each forewing, and eyespots ringed with orange on the hindwings. It has a wingspan of up to 7 cm. The Sword-grass Brown Butterfly also has a very distinctive flight pattern (a very slow, fluttering flight). Its size, wing markings and flight pattern easily distinguishes it from other butterfly species with which it shares its habitat.

This butterfly is dependent on Red-fruited Saw-sedge, which is the only food plant of the Sword-grass Brown caterpillar. The Red-fruited Saw-sedge as its name suggests, has sharp, cutting, strap-like leaves. When fruiting, its bright red seeds are conspicuous, hanging down from the old flower stem. It is a plant species found in wet and swampy forests and this type of habitat occurs only in small isolated pockets within the City of Knox.

Sword-grass Brown Butterfly can be seen

Fig. 1. The Sword-grass Brown Butterfly *Tisiphone abeona albifascia.*

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flying on sunny days in the warmer months, between November and March and it is typically seen flying around the Red-fruited Saw-sedge. After mating, eggs are laid singly on the plant and once the eggs hatch, the leaves become food for the developing caterpillar. The caterpillar is beautifully camouflaged on its food plant, during the day it is found hiding near the base of the tussock and on the underside of the leaves, it emerges at night to feed. The presence of the Red-fruited Saw-sedge is essential for the continued survival of the butterfly.

Local Populations

The four sites in which small populations of the Sword-grass Brown Butterfly are known to occur in Knox are at Wicks Reserve (managed by Knox City Council) , Old Joes Creek Retarding Basin, Liverpool Road Retarding Basin (both managed by Melbourne Water Corporation) and Eastwood Golf Course. The reserves are 1.5–3 km apart and interaction between these butterfly populations is unknown, but is thought to be limited. These sites all contain relatively small and isolated areas of suitable Red-fruited Saw-sedge habitat.

Wicks Reserve supports the greatest butterfly population density, this is evident by the numbers of butterflies seen flying, and the number of larvae located by active searching of the food plant. This reserve is a *Land for Wildlife* property managed by Knox City Council and fortunately has a substantial amount of the Red-fruited Saw-sedge. Within this reserve, the populations of Sword-grass Brown Butterfly are found in two distinct habitats. One is a Swamp Gum *Eucalyptus ovata* Riparian forest with Red-fruited Saw-sedge, Variable Sword-sedge *Lepidosperma laterale*, Hop Goodenia *Goodenia ovata* and Swamp Paperbark *Melaleuca ericifolia* in the understorey. The other habitat is a drier site where Red-fruited Saw-sedge grows with Prickly Tea-tree *Leptospermum continentale*, Furze Hakea *Hakea ulicina* and Long Purple-flag *Patersonia occidentalis* as well as other species. Wicks Reserve is situated near the base of Mt. Dandenong and, if our project is successful, will ultimately form part of a movement corridor for the butterfly that will begin in Boronia Heights at the Old Joes Creek Retarding Basin where butterfly habitat also exists.

Project Activities

Revegetation and Propagation Activities

To date, planting of suitable habitat for the Sword-grass Brown Butterfly has been undertaken at six reserves and three schools situated in The Basin-Boronia area (Fig. 2). Plantings have consisted of Red-fruited Saw-sedge and species commonly associated with it, such as the above mentioned species in Wicks Reserve. Enrichment planting of Red-fruited Saw-sedge and other management of butterfly habitat has also been undertaken at Wicks Reserve and Old Joes Creek (eg. weed control - Melbourne Water has removed Pampas Grass from Old Joes Creek). Local school children have been involved, undertaking plantings within their school yards and also taking part in plantings within the reserves. Local residents in Stanley St., The Basin (adjoining George Grumont Reserve) have also assisted and planted over 100 Red-fruited Saw-sedge tubes in their own backyards to help increase habitat for this butterfly.

An important part of this project has been the need to propagate Red-fruited Saw-sedge to provide sufficient plants for habitat plantings. The Knox Environment Society operates a community nursery, and it is here that treatments of smoke and acid have been applied to recently collected seed and seed sown after a years storage. Experience has shown that older seed of Red-fruited Saw-sedge germinates quite well, but in some cases an application of dilute sulphuric acid has improved germination, although smoke has elicited a similar effect with other *Gahnia* sp. seed. We hope that by undertaking this work on the germination of Red-fruited Saw-sedge we can not only supply the thousands of plants needed for the project, but also limit the need for people to dig up seedlings from the bush to provide butterfly habitat elsewhere.

Community Art

Another dimension to the project has been the installation of butterfly-shaped bollards at each of our habitat restoration sites and a Sword-grass Brown Butterfly Project sign

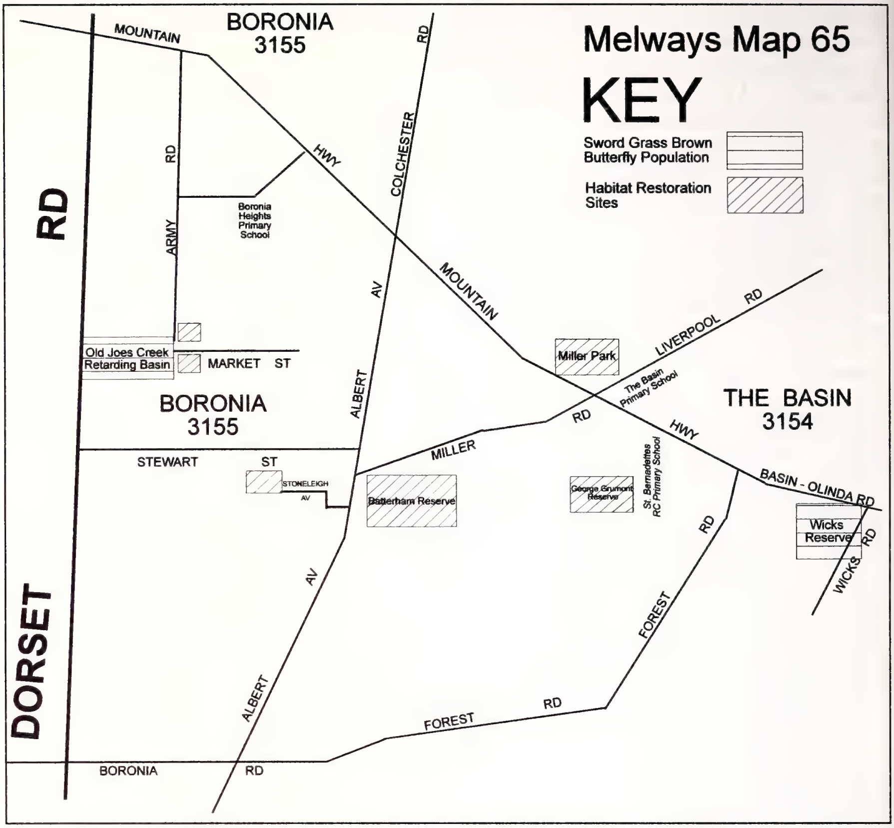

Fig. 2. A map of existing Sword-grass Brown Butterfly populations at six reserves and three schools situated in The Basin–Boronia area.

(incorporating a model of a Sword-grass Brown Butterfly that spins) (Fig. 3). These attractive wood carvings identify these sites as habitat plantings for the butterfly. Knox Placemakers (a local community arts program charged with decorating most new buildings and public spaces within the city of Knox), with some community assistance at the 1996 Stringybark Festival, created the bollards and sign for our group. A Community Grant from Parks Victoria funded the construction.

Monitoring

The Sword-grass Brown Butterfly Project is in the process of developing a long term monitoring program at Wicks Reserve, Old Joes Creek and at our revegetation sites. We intend to monitor both the larvae and the adult. The information gathered will contribute to our knowledge of the butterfly and also measure the success of this project. The good news is that the butterflies have been observed at three of the revegetation sites, but it is yet to be seen whether the Sword-grass Brown butterfly will deposit eggs on the planted Red-fruited Saw-sedge.

Translocation

In 1997 the Sword-grass Brown Butterfly Project attempted translocation of a small number of Sword-grass Brown larvae (6) into apparently suitable habitat in Dexters Bush, Heathmont. Dexters Bush is an area of heathland which regenerated following removal of Pine trees *Pinus radiata,* and now supports a high density of Red-fruited Saw-sedge, among other plants. Larvae were collected from known populations during the day and translocated the same day. We were conscious of over-collection

of larvae from small populations at established sites, so the plants within the area were searched for 15 minutes to ensure adequate number of larvae were present. If five or more larvae were found during the 15 minute search, the population was considered dense enough to allow removal of one larva for translocation. A data sheet was compiled and a record made of where each larva was collected, its position on the plant, size of the larva, size of the plant, presence/absence of flower stem, etc. The larvae were approximately 2–3 cm in length at the time of collection. They were translocated to marked Red-fruited Saw-sedge at Dexters Bush. These plants were subsequently checked for signs of feeding and the site was regularly walked to search for emerged adults.

This translocation program was unsuccessful. The reasons are unknown, but several possibilities are proposed: the number of larvae translocated was too small; Summer 1997-98 was too dry (generally it was not a good butterfly season), or habitat type or microclimate was unsuitable. A population of Sword-grass Brown Butterfly was subsequently discovered nearby in a privately owned remnant forest with Red-fruited Saw-sedge understorey.

Conclusion

The Knox Environment Society hopes that the Sword-grass Brown Butterfly Project will grow to become an important and valued project for the community living in The Basin-Boronia. While linking distant butterfly populations may be some years off, we hope that the project serves a useful educational role in displaying the importance of preserving, managing and creating habitat for all of our fauna, small or large, even in the suburbs!

Fig. 3. The Sword-grass Brown Butterfly Project sign.

Acknowledgments

K.E.S. members and the local community have driven this project. Thank-you to students from St. Bernadette's, The Basin, Boronia, Boronia Heights and Karoo Primary Schools for their enthusiastic assistance with plantings. The Sword-grass Brown Butterfly Project has received financial assistance from the Department of Natural Resources and Environment, Melbourne Water Corporation, Parks Victoria, and City of Knox. Financial and logistic advice has been received from Operation Revegetation Pty. Ltd.. Logistic advice has also been received from entomologists from LaTrobe University (Tim New), Victorian Entomological Society (Kelvyn Dunn) and the Museum of Victoria (Alan Yen, John Wainer and Ross Field).

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Letter to the Editors

Dear Editors

Re Naturalist Note in The Victorian Naturalist 115 (3) 1998, p 106

I would like to acknowledge the help of Dave Munro of Dunkeld who alerted me to the whereabouts of a copy of *Robert Dick, Baker of Thurso.* Another fan of Robert Dick, Dave found a copy at Bellcourt Books, Hamilton. I now have an 1878 edition, 120 years old, in mint condition. I am indeed delighted. Many thanks.

Christy Jordan

From our Naturalist in the Country

A Day's Rambling, Gippsland-style

October, a sunny day after a sun-spangled dewy dawn. The nearby Won Wron Forest beckoned, hills a soft emerald, the Strzeleckis and Prom junior navy. However, the western sky glowered steel grey, clouds cauliflowering, promise of more rain.

A squiring of Choughs greeted us at the forest entrance, their clay nest over the roadway. The bush resounded to bird calls: Kookaburra, White-throated Treecreeper, Pallid Cuckoo, Red Wattlebird, Pied Currawong and Rufous Whistler, while Yellow and Scarlet Robins, Superb Fairy Wren and Grey Fantail flirted in the lower canopy. Brilliant cobalt flashes heralded Crimson Rosellas and hideous shrieking a flight of Sulphur-cresteds, but Gang-gangs were detected by the continuous rain of chewed seeds and flowers from on high.

Table drains were heavily clogged with sharp sand, mounds built up by ants in anticipation of further deluges. Scurrying ants mazed the floor, with evidence of Echidna snuffle marks. We found an Echidna busily burrowing under a log, while another merely rolled into a ball at our approach. Nearby swamps echoed with the 'boonng' of Banjo Frogs, the canopy a mix of stringybarks with the occasional bluegum.

Bestrewn with wildflowers, the thick leaf litter was a tapestry of colour, threaded with embroidery silks: reds of Running Postman and correas; blue of Speedwell, Dampiera, Love Creeper, Blue Stars; yellow Guinea-flower, Groundsel, pea flowers, Billy Buttons, Gold Stars; Pink Heath, Grass Triggers, Pink-bells; purple Sarsaparilla, lilies, violets, Austral Bugle; and the creams of Clematis, Riceflower, Milkmaids, Candles. These were lit from above with the glow of wattle and banksia cones, the stars of Teatree and Kunzea.

On this balmy day reptiles were abroad. The merest shadow sent Metallic Skinks scuttling for cover, but we searched in vain for a Jacky Dragon. Doubtless its lithe grey body blotched with cream was perfectly camouflaged, motionless. Nevertheless, we saw a Red-bellied Black Snake sunning itself, a shining black twist of shimmering silk, coral-edged – and a six foot Lace Monitor. We froze as the greyish black monster with white throat mottling, fierce claws and flickering tongue, lumbered slowly above us on a road cutting before selecting the perfect spot on buttressed roots to sun itself.

Orchids, though, were our quarry. A mauve drift beckoned, hundreds of Waxlips in shades of purple, amethyst, lilac. The moist forest floor was a-dance with a ballet of pirouetting Pink Fingers here, a gavotte of Musky Caledanias there, a tarantella of Pterostylis everywhere. October is the month, a marriage of mosquitoes and orchids, but, to me, hell and heaven - to stand in awe at such fragile and exquisite beauty, yet be attacked ferociously by so many foes!

Our tally mounted, with colonies in flower, carpets of leaves, some in tiny clusters, others appearing singly: Mayfly, Gnat, Mosquito, Pink Fingers, a patch of eighty Hare Orchids in a burnt area, Donkeys, Leopard Orchids, Red Beaks, Brown Beaks, Waxlips, Purple Beard, Common Birds, Caledenias and Greenhoods galore, Common Onion and Sun Orchids........

One grove had a cathedral atmosphere, a tranquil sanctuary redolent with bush incense, shafts of pure light streaming from lofty height. Starry clematis garlanded the pillars, flatpea coloured the banks, mossy carpet revealing a treasure trove: delicate maroon Bird Orchids, beaks agape in praise, kneeling before velvety pews studded with jewel-like fungi.

What a day, an extravaganza, a feast for the senses.

Terri Allen
86 James Street, Yarram, Victoria 3971.

Orchids seen on a sunny day in October.

Beard Orchid, Purple	*Calochilus robertsonii*
Bird Orchid, Mountain	*Chiloglottis valida*
Brown Beaks	*Lyperanthus suaveolens*
Caladenia, Bronze	*Caladenia iridescens*
Caladenia, Dusky	*Caladenia fuscata*
Caladenia, Fairy	*Caladenia alata*
Caladenia, Musky	*Caladenia gracilis*
Caladenia, Orange-tip	*Caladenia aurantiaca*
Caladenia, Tiny	*Caladenia pusilla*
Caladenia, White	*Caladenia catenata*
Donkey Orchid	*Diuris corymbosa*
Duck Orchid, Large	*Caleana major*
Duck Orchid, Small	*Caleana minor*
Gnat Orchid	*Cyrtostylis reniformis*
Greenhood, Alpine	*Pterostylis alpina*
Greenhood, Bearded	*Pterostylis plumosa*
Greenhood, Nodding	*Pterostylis nutans*
Greenhood, Slender	*Pterostylis foliata*
Greenhood, Tall	*Pterostylis longifolia*
Hare Orchid	*Leptoceras menziesii*
Maroonhood	*Pterostylis pedunculata*
Mayfly Orchid	*Acianthus caudatus*
Mosquito Orchid, Small	*Acianthus pusillus*
Onion Orchid, Common	*Microtis unifolia*
Pink Fingers	*Caladenia carnea*
Red Beaks	*Lyperanthus nigricans*
Spider Orchid, Greencomb	*Caladenia dilatata*
Spider Orchid, Southern	*Caladenia australis*
Spider Orchid, Thick-lip	*Caladenia tessellata*
Sun Orchid, Dotted	*Thelymitra ixioides*
Sun Orchid, Salmon	*Thelymitra rubra*
Sun Orchid, Slender	*Thelymitra pauciflora*
Sun Orchid, Twisted	*Thelymitra flexuosa*
Tiger Orchid	*Diuris sulphurea*
Wax-lip Orchid	*Glossodia major*

John Gould in Australia: Letters and Drawings

by Ann Datta

Publisher: *The Miegunyah Press, Melbourne University Press, Carlton South, Victoria. in association with the Natural History Museum, London, 1997. xiv + 502 pp. RRP $80.00.*

This book is one of an increasing number of handsome publications from the Miegunyah Press. Moreover, its subject, John Gould, is one that is eminently suited to lavish pictorial treatment. Gould is famous for his own beautifully illustrated books on birds, several volumes of which are devoted to Australian species. Datta came up with the idea of a book on Gould as she worked on cataloguing two of his manuscript collections at the Natural History Museum, London. The result is half a catalogue of letters and drawings relating to Australia, which come from these collections, and half a life and times, which puts the catalogued material in context. In addition, there are two appendices listing the 191 species of Australian birds first described by Gould, and his 45 Australian mammals.

As a librarian, Datta is well-qualified to put the catalogue together, and her librarianship skills are also evident in the life and times, where there is much scrupulous detail on Gould's various publications. The four pages of acknowledgements at the start of the book indicate that she has been careful to seek expert opinions regarding other aspects of Gould's life and work. These she presents in a series of thematic rather than chronological chapters. The book lacks a strong narrative thread, but given the fact that several biographies of Gould have already been written, she had no need to cover old ground, although there are new details on Gould's early working life as a gardener and on the precise requirements of his work for the Zoological Society of London.

Gould has attracted much attention by biographers not only because he made a substantial contribution to a very popular science, but because his is also the perennially interesting rags to riches story. In fact he may be the only ornithologist to get rich from working on birds. Australia has a

significant place in this story. Gould was here for 19 months from 1838, although he dominated Australian ornithology from 1837, when he first started publishing on Australian birds, to his death in 1881. He seems to have had an insatiable curiosity when it came to birds and could seldom be deflected from this subject. His brother-in-law once complained, 'birds, birds are all you care about'. In the case of Australia, however, mammals also attracted Gould's attention, and his only mammal publication came out of his visit here.

Most chapters of the life and times are, as one would expect, devoted to Australia. Datta uses the manuscripts she has catalogued along with other sources to detail how Gould was able to turn his trip into a profitable undertaking. Gould developed an interest in the distinctive Australian avifauna as collections made their way to him in London. By the 1830s there were a number of publications which contained information on Australian birds, but no good general work on the subject. Gould saw this lack as a publishing and scientific opportunity for himself. Subscribers who bought his *Birds of Australia* not only received the latest information on a subject of general curiosity among naturalists, but also in a beautifully presented and technically innovative format.

Datta starts with the apparently simple aim 'to present the facts' but her interpretations are not only evident but valuable. She acknowledges the controversies that have dogged Gould's reputation as an artist and gives her assessment of them. She asserts that there is enough surviving evidence to say that Gould could and did draw birds competently and that his role in designing the plates for his books entitled him to be listed on them as a co-producer. Gould was usually reasonably scrupulous in acknowledging the work of the other artists employed in the production of his books, be it in the drawing, lithography, printing or colouring. Datta reserves her greatest praise for the artwork of Edward Lear and thinks Elizabeth Gould's contributions, although technically competent, lack Lear's vitality.

The second half of Datta's book is essentially a reference work. It is a descriptive catalogue of letters, manuscripts and drawings regarding Australia in either the Gould Australian Collection or Gould Correspondence Collection at the Natural History Museum, London. Datta also includes material from the collections which relate to New Zealand. Entries are arranged alphabetically by the name of the person who corresponded with Gould, or who was responsible for documents or drawings which passed into Gould's possession. Datta gives abstracts of the letters and descriptions of drawings. The correspondents include internationally famous names like Charles Darwin and prominent Australian naturalists such as Edward Ramsay and George Bennett. Letters from, as well as to, Gould are represented.

Because of my own long-standing interest in Ferdinand von Mueller I could not resist looking him up and was rewarded with a reference to one letter (to Richard Owen) and two newspaper cuttings. The items are about Mueller's little known involvement in the description of a new species of Cassowary discovered by G. Randall Johnson at Rockingham Bay, Queensland. The catalogue in Datta's book will be most useful for individuals, like myself, interested in research questions and the life and times chapters will please readers with a general interest in Gould's contribution to knowledge of Australian birds and mammals. The substantial number of coloured illustrations, many showing different stages in the development of Gould's plates, are also a valuable source on natural history art.

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Planting Wetlands and Dams.
A Practical Guide to Wetland Design, Construction and Propagation

by Nick Romanowski

Publisher: *University of New South Wales Press, Sydney 1998*
80 pages, paperback, RRP $22.95.

This small book is a mine of information for those wishing to create or restore wetlands and plant out farm dams.

The opening chapter lists the various types of wetlands which occur in non-tropical Australia. Wetlands have been classified by various professions, engineers look at wetlands differently from botanists. Nick Romanowski has created his own practical definitions, and lists 11 categories of wetland which are easily understood by the amateur. Each category is described in detail with comments on the threats to each type. Worldwide wetlands are decreasing due to changes in water tables, soil erosion and drainage changes caused by development.

The author provides information on exactly how to plan and design a wetland. First he suggests that goals must be defined; is the proposed wetland purely to beautify an area, or are stock to use the water? An approach to local authorities to obtain information on local regulations and permits is a must. This information together with a knowledge of the local climate, topography, soils and vegetation can then be taken into account when determining the site and aspect. Modifications and extensions to existing dams, etc. are discussed.

Nick assures the reader that construction of wetlands is not particularly difficult. He writes about the problems and advantages of particular soil types, followed by brief descriptions of the types of machinery which are available, and the pros and cons of each for different soils and topography. The problems of water control are explored for small and large constructions.

Chapter 4 is a comprehensive section about plant selection, propagation and planting. The disadvantages of using exotic species and the advantages of local vegetation are explained, followed by reasons for using certain species. Propagation methods are discussed, including the collection and treatment of seeds or cuttings, the use of different soils, fertilisers and watering methods. Tips on when to plant a new wetland and how to cope with varying water levels are included. Information on control methods for plant and animal pests which may be encountered are listed.

A plant list of wetland genera, with brief details and a glossary, together with a reading list appear at the end of the book. More detailed species information is available in Nick's first book *Aquatic and Wetland Plants: a Field Guide for Non-tropical Australia.* A photographic central section, together with brief descriptions, illustrates many of the ideas discussed.

The chatty format of this book was spoilt for me by the difficulty in reading the small, grey type and the generally cramped design of the book, especially near the spine. Presumably, this was done in the interests of economy, but my aging eyes were challenged. The book could be easily read over a weekend, but as it is a book which will be used again and again as a reference when building a wetland, I would have liked to see more headings making it easier to find specific information.

The book certainly includes most of the information needed to construct a wetland. I was disappointed to find that little reference was made to attracting birds to the wetlands, or suggestions on planting to create suitable flight paths, although mention is made of habitat requirements for other aquatic species.

However, if you are planning to construct or enlarge a wetland this book is a worthwhile addition to your library.

Kathie Strickland
3 Beatty Avenue, Bittern, Victoria 3918.

Flora and Fauna Guarantee Act 1988
Recent Action Statements: May 1998

Ten recently produced FFG Action Statements have been received:
Northern Sandalwood *Santalum lanceolatum* - No. 75.
Smooth Darling Pea *Swainsona galegifolia* - No. 76.
Giant Gippsland Earthworm *Megascolides australis* - No. 77.
Bush Stone-curlew *Burhinus grallarius* - No. 78.
Brush-tailed Phascogale *Phascogale tapoatafa* - No. 79.
Predation of native wildlife by the Cat *Felis catus* - No. 80.
Concave Pomaderris *Pomaderris subplicata* - No. 81.
Yellow Hyacinth Orchid *Dipodioum hamiltonianum* - No. 82.
Grey Falcon *Falco hyploleucos* - No. 83.
Black Gum *Eucalyptus aggregata* - No. 84.

Also listed alphabetically is an index of Action Statements up to Number 74.

Fauna
Barred Galaxias *Galaxias olidus var. fuscus* - No. 65.
Baw Baw Frog *Philoria frosti* - No. 55.
Black-eared Miner *Manorina melanotis* - No. 26.
Bridled Nailtail Wallaby *Onychogalea fraenata* (Extinct Mammals 2) - No. 14.
Brush-tailed Bettong *Bettongia penicillata* (Extinct Mammals 2) - No. 14.
Brush-tailed Rock-wallaby *Petrogale penicillata* - No. 19.
Dandenong Freshwater Amphipod *Austrogammarus australis* - No. 3.
Eastern Barred Bandicoot *Perameles gunii* - No. 4.
Eastern Hare-wallaby *Lagorchestes leporides* (Extinct Mammals 1) - No. 13.
Eastern Quoll *Dasyurus viverrinus* (Extinct Mammals 2) - No. 14.
Eltham Copper Butterfly *Paralucia pyrodiscus lucida* - No. 39.
Giant Burrowing Frog *Heleioporus australiacus* - No. 61.
Grey-crowned Babbler *Pomatostomus temporalis* - No. 34.
Helmeted Honeyeater *Lichenostomus melanops cassidix* - No. 8.
Hemiphlebia Damselfly *Hemiphlebia mirabilis* - No. 46.
Hooded Plover *Charadrius rubricollis* - No. 9.
Large Ant-blue butterfly *Acrodipsas brisbanensis* - No. 70.
Leadbeater's Possum *Gymnobelideus leadbeateri* - No. 62.
Lesser Stick-nest Rat *Leporillus apicalis* (Extinct Mammals 1) - No. 13.
Little Tern *Sterna albifrons sinensis* - No. 51.
Long-footed Potoroo *Potorous longipes* - No. 58.
Malleefowl *Leipoa ocellata* - No. 59.
Mallee worm- lizard *Aprasia aurita* - No. 20.
Mountain pygmy-possum *Burramys parvus* - No. 2.
New Holland Mouse *Pseudomys novaehollandiae* - No. 74.
Orange-bellied Parrot *Neophema chrysogaster* - No. 43.
Otway Stonefly *Eusthenia nothofagi* - No. 45.
Paucident Planigale *Planigale gilesi* - No. 52.
Pig-footed Bandicoot *Chaeropus ecaudatus* (Extinct Mammals 1) - No. 13.
Plains Mouse *Pseudomys australis* (Extinct Mammals 2) - No. 14.
Plains Wanderer *Pedionomus torquatus* - No. 66.
Rabbit-eared Tree-rat *Conilurus albipes* (Extinct Mammals 1) - No. 13.
Red-tailed Black Cockatoo *Calyptorhynchus banksii graptogyne* - No. 37.
Red-tailed Phascogale *Phascogale calura* (Extinct Mammals 2) - No. 14.
Regent Honeyeater *Xanthomyza phrygia* - No. 41.
Rufous Bettong *Aepyprymnus rufescens* (Extinct Mammals 2) - No. 14.
Rufous Bristlebird *Dasyornis broadbenti* - No. 49.

Small Ant-blue butterfly *Acrodipsas myrmecophila* - No. 71.
Southern Lined Earless Dragon *Tympanocryptis lineata lineata* - No. 35.
Spotted Bowerbird *Chlamydera maculata* - No. 64.
Striped Legless Lizard *Delma impar* - No. 17.
Superb Parrot *Polytelis swainsonii* - No. 13.
Tasmanian Bettong *Bettongia gaimardi* (Extinct Mammals 2) - No. 14.
Tasmanian Pademelon *Thylogale billardierii* (Extinct Mammals 2) - No. 14.
Tiger Quoll *Dasyurus maculatus* - No. 15.
Trout Cod *Maccullochella macquariensis* - No. 38.
Variegated (Ewen's) Pygmy Perch *Nannoperca variegata* - No. 42.
Western Barred Bandicoot *Perameles bougainville* (Extinct Mammals 2) - No. 14.
White-bellied Sea-eagle *Haliaeetus leucogaster* - No. 60.
White-browed Treecreeper *Climacteris affinis* - No. 69.

Flora
Audas' Spider Orchid *Caladenia audasii* - No. 24.
Austral Toad flax *Thesium australe* - No. 56.
Bald-tip Beard-orchid *Calochilus richiae* - No. 5.
Brittle Greenhood *Pterostylis truncata* - No. 63.
Buff Hazelwood *Symplocos thwaitesii* - No. 67.
Button Wrinklewort *Rutidosis leptorrhynchoides* - No. 28.
Buxton Gum *Eucalyptus crenulata* - No. 1.
Dainty Maidenhair *Adiantum capillus-veneris* - No. 16.
Dwarf Lantern-bush *Abutilon fraseri* - No. 48.
Filmy Maidenhair *Adiantum diaphanum* - No. 11.
Gaping Leek-orchid *Prasophyllum correctum* - No. 57.
Hairy Anchor Plant *Discaria pubescens* - No. 47.
Hairy-pod Wattle *Acacia glandulicarpa* - No. 73.
Kamarooka Mallee *Eucalyptus froggattii* - No. 27.
Large-fruit Groundsel *Senecio macrocarpus* - No. 68.
Leafy Greenhood *Pterostylis cucullata* - No. 54.
Limestone Caladenia *Caladenia calcicola* - No. 23.
Maiden's Wattle *Acacia maidenii* - No. 36.
Mallee Hemichroa *Hemichroa diandra* - No. 29.
Narrow Goodenia *Goodenia macbarronii* - No. 72.
Rough Eyebright *Euphrasia scabra* - No. 10.
Slender Myoporum *Myoporum floribundum* - No. 30.
Small Psoralea *Psoralea parva* - No. 31.
Stiff Groundsel *Senecio behrianus* - No. 12.
Tall Astelia *Astelia australiana* - No. 7.
Warby Swamp Gum *Eucalyptus cadens* - No. 21.
Wedge Diuris *Diuris cuneata* - No. 22.
Whipstick Westringia *Westringia crassifolia* - No. 40.
Wilga *Geijera parviflora* - No. 25.

Communities
Butterfly Community No. 1 - No. 6.
San Remo Marine Community - No. 18.
Western (Basalt) Plains Grassland Community - No. 53.

Threatening Processes
Predation of native wildlife by the introduced Red Fox *Vulpes vulpes* - No. 44.
The use of lead shot in cartridges for hunting waterfowl - No. 32.

Copies of all FFG documents are held in the FNCV library.

The Field Naturalists Club of Victoria Inc.

Reg No A0033611X

Established 1880

In which is incorporated the Microscopical Society of Victoria

OBJECTIVES: ***To stimulate interest in natural history and to preserve and protect Australian flora and fauna.***

Membership is open to any person interested in natural history and includes beginners as well as experienced naturalists.

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Members receive *The Victorian Naturalist* and the monthly *Field Nat News* free. The Club organises several monthly meetings (free to all) and excursions (transport costs may be charged). Field work, including botany, mammal and invertebrate surveys, is being done at a number of locations in Victoria, and all members are encouraged to participate.

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	Year	Half-Year
First Member		
Metropolitan	$40	$20
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Mount Buffalo Centenary Issue

Published by The Field Naturalists Club of Victoria since 1884

F.N.C.V.

This issue supported by Parks Victoria

Parks
VICTORIA

Mount Buffalo.
Adapted from Parks Victoria map, by Anne Morton.

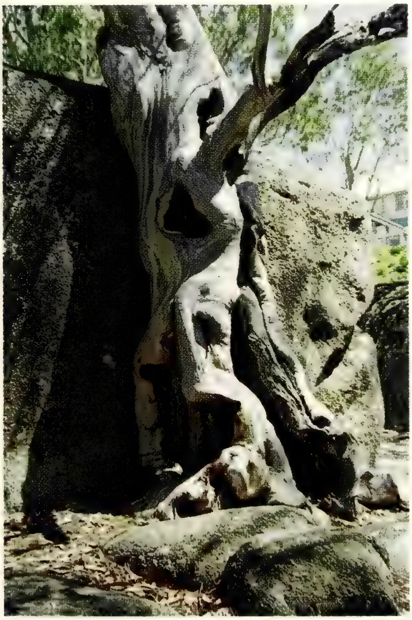
PLATE 1

A. FNCV Mount Buffalo Excursion February 1998; Botanists at work on Wild Dog Plain. Photo by Sharon Ford.

B. FNCV Mount Buffalo Excursion February 1998; Dragonfly hunting in the Reservoir. Photo by Sharon Ford.

C. FNCV Mount Buffalo Excursion February 1998; Setting up and monitoring transects opposite Tatra Inn. Photo by Sharon Ford.

D. FNCV Mount Buffalo Excursion February 1998; Geologists at work on Wild Dog Plain. Photo by Sharon Ford.



E. .FNCV Mount Buffalo Excursion February 1998; Snow Gum *Eucalyptus pauciflora* growing in granite near the Chalet. Photo by Sharon Ford.

F Buffalo Mint Bush *Prostanthera monticola*, Mount Buffalo, December 1985. Photo by Malcolm Calder.

PLATE 2

A. St. John's specimen White Everlasting *Helichrysum andenophorum* var. *waddelliae* Photo by Ron Fletcher.

B. White Everlasting *Helichrysum andenophorum* var. *waddelliae*, in 1998 Photo by Ron Fletcher.

C. St. John's specimen Hoary Sunray *Leucochrysum albicans*. Photo by Ron Fletcher.

D. Hoary Sunray *Leucochrysum albicans*, in 1998. Photo by Ron Fletcher.

PLATE 3

The Victorian Naturalist

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Editors: Ed and Pat Grey
Assistant Editor: Merilyn Grey

Mount Buffalo Articles

ISSN 0042-5184

Cover: FNCV Mount Buffalo Excursion, February 1998; Botanists monitoring transect lines near the Tatra Inn. Photo by Sharon Ford.

Find us on the WEB: http://calcite.apana.org.au/fncv/

Introduction

Tom May[1]
President Field Naturalists Club of Victoria

This volume is the first of two special issues of *The Victorian Naturalist* commemorating the centenary of the reservation of National Parks at Mount Buffalo and at Wilsons Promontory. The Field Naturalists Club of Victoria (FNCV) played an important role in the establishment of the National Park at the Prom and for 100 years has been a voice for environmentally sound management of National Parks.

My strongest image of Mount Buffalo is from a summer visit to the highest point on the Buffalo Plateau, The Horn. I was hunting for a toadstool *Hygrophorus flammans,* the type and only specimen of which was collected by Ferdinand von Mueller from The Horn. I did not re-locate the fungus, but ascending to the summit I encountered an ever-thicker flutter of Bogong Moths madly flying in the still-balmy dusk air. They were emerging from their daytime rest, packed tightly in crevices between the granite tors. From the topmost tor was a quintessential view of the Australian Alps - serried spurs and ridges receding in ever-deepening bluish hues through the haze of bushfires. Against this splendid backdrop, a family of kestrels caught Bogong Moths on the wing, one moment landing on a tor nearby, the next far out over the precipitous drop. I watched entranced until the birds were barely visible in the evening gloom among the millions of moths, and wondered if the moths returned to the same crevice each night.

This experience captured for me the immense value of National Parks such as Mount Buffalo - a place of great scenic beauty, resonant with Koori and with European explorer and settler histories, and of course a patchwork of diverse habitats with a rich natural history. The collection of papers in this special issue reflects the importance of Mount Buffalo National Park as a site par excellence for the study and appreciation of natural history.

Houghton describes the involvement of the FNCV with Mount Buffalo, through excursions, articles in *The Victorian Naturalist* and lobbying in relation to management; an example of which concerns cattle grazing on the Buffalo plateau - a damaging activity removed in 1956, but still persisting in some alpine areas in Victoria.

Calder and Calder call for the recognition of the importance of scientific research in relation to National Parks. The Calders argue that the isolated granite island of Mount Buffalo National Park is an ideal locale for carrying out research on topics such as the effect of visitors on the Park environment, and global warming. They decry the trend by Governments to undervalue the research that is needed to answer such important questions.

For areas of significant natural or cultural values, Special Protection Zones provide additional protection and **Marion** describes the 19 such zones at Mount Buffalo set-up to protect Aboriginal sites and rare biota. She outlines the management of these zones, and notes the importance of contributions by volunteers.

The granite tors which are such a feature of the Mount Buffalo landscape form the subject of an analysis by **Schleiger** of the alignment of major joints, xenoliths and dykes. He demonstrates that similar stresses were operating during the folding of the adjoining Ordovician sediments and the crystallization of the Buffalo granite.

Walsh considers the flora of Mount Buffalo, the most isolated peak of the Victorian Alps, and poses the question 'botanical bridge or island?'. He notes the relatively high number of endemic plants, and discusses widespread alpine species, suggesting that the greatest botanical affinity of Mount Buffalo is with the Baw Baw Plateau.

Mount Buffalo was the site of the first foray into the botanically little-known Australian Alps by Ferdinand von Mueller in 1853. **Gillbank and Maroske** assess the taxonomic imprint of Mueller on the flora of Mount Buffalo, documenting the plants which he collected and named.

Percival St John along with other FNCV members, was active in the documentation of the flora and fauna of natural areas, and

[1]Royal Botanic Gardens Melbourne, Birdwood Ave, South Yarra, Victoria 3141

Fletcher revisits the set of 135 plant specimens made by St John on the Buffalo Plateau. Fletcher updates the names used by St John and illustrates characteristic species, some of which can still be found in the exact places recorded by St John.

Heinze and co-authors focus on the ecology of the rare Buffalo Sallow Wattle, endemic to the Buffalo Plateau. Many individuals are infested by galls, presumed to be caused by rust fungus. The authors discuss factors affecting distribution of the wattle, noting that fire may extend the range, which eventually contracts with competition from other plants. Another endemic, Buffalo Sallee, is the subject of a study by **Lawler** and co-authors, who assess the impact of fire and competition on the species.

The inventory of the native vascular plant flora of Mount Buffalo begun by Mueller, and continued by field naturalists such as St John, is now close to 450 species, with the likelihood of few additions. Documentation of non-vascular plants (algae, fungi, lichens, bryophytes) is much less complete. For lichens, **Ford** increases the listed number of Mount Buffalo species from six to 35, among which are two newly recorded for Victoria.

Among the animals, even in well documented groups, there is much to learn of the distribution and ecology of individual species. **Crosby** increases the list of butterflies known from Mount Buffalo to 30. The Alpine Silver Xenica is endemic to the Buffalo Plateau, and explanations are advanced for the restricted distribution of this, and other alpine butterflies.

Macroinvertebrates include such groups as molluscs, worms and mites, and insects like mayflies, dragonflies and stoneflies. **Hawking** documents the biology and ecology of common and interesting species among the great diversity of macroinvertebrates in just one Mount Buffalo habitat - freshwater. **Mikrjukov and Croome** investigated an unusual group of protozoa, the 'sun animalcules' (Heliozoa), in an unusual habitat, ice-covered ponds on the Buffalo plateau. They discovered six heliozoans and one heliozoan-like amoeba, four of which were newly recorded for Australia. Their collections also expand knowledge of the ecology of the species, previously thought not to occur in an active state during winter. Another lesser known group of protozoa is the testate amoebae, which have a covering of materials such as minute sand particles. **Meisterfeld and Tan** record these tiny animals for the first time from Mount Buffalo, cataloguing 89 taxa, of which 34 are new records for Australia. This level of diversity is comparable to that found at any previously surveyed locality in Australia. In zooplankton from Lake Catani and streams in the surrounding area **Shiel and Griggs** found a diversity of microfauna, including testate amoebae, rotifers and microcrustacea; 75 species in all. Again, many are newly recorded from Mount Buffalo, with a number recorded for the first time from Australia.

The spectacular landscape of the Buffalo Plateau has inspired many artists and photographers. **McBain** presents examples of such depictions in relation to the history and natural history of the area. He illustrates changes in vegetation cover, and development as revealed by photographs.

In the concluding paper, **Jacobs** gives an overview of the history of Mount Buffalo, from the presence of the Minjumbuta people, through early European exploration and settlement, to the birth of tourism and the subsequent calls for a National Park.

The challenge of the century since the reservation of National Parks at Mount Buffalo and Wilsons Promontory has been the creation a representative system of statewide conservation reserves. While this task is not yet complete, the challenge now for existing Parks is management to ensure that the diversity of species and habitats is preserved for centuries to come. Thus, conservation is not merely achieved by the establishment of a Park, but requires on-going monitoring and research. Jacobs (this issue) considers that 'to the best of our knowledge the park is in good condition'. The contributions in this issue on the biota of Mount Buffalo strengthen the knowledge base of the Park's biota, but also indicate that there is still much to be learnt, (particularly among the less obvious plants and animals such as lichens and protozoa). At Mount Buffalo there is much to interest field naturalists, and much to which they can continue to make important contributions.

Mount Buffalo and The Field Naturalists Club of Victoria; an Historic Account

Sheila Houghton[1]

Abstract
Individual members of The Field Naturalists Club of Victoria (FNCV) had made a number of trips to Mount Buffalo, extolling its beauty and natural history, but it wasn't until 1903, when the railway passed by Porepunkah that an official 'camp-out' was arranged. Since then, a number of excursions have been organised - in 1937, 1940, 1978, 1990 and 1998. As a result of the earlier excursions and the FNCV members' interest in the botany of the plateau, the club was actively involved in moves to protect the park from cattle grazing and further development. (*The Victorian Naturalist* **115** (5), 1998, 160-163).

When Charles Walter visited Mount Buffalo in 1899, the Government had already made the first temporary reservation of 1165 ha around Eurobin Falls, in 1898. There is no recorded account of any previous visit to the area either by the Field Naturalists Club of Victoria (FNCV), or by individual members. Dr Mueller had visited in 1853, but that was more than 25 years before the founding of the Club. The energies of the Club had been absorbed in campaigning for the reservation of Wilsons Promontory, with which there were closer links throughout the last century, when Mount Buffalo had not attracted their attention.

The reasons for this were two-fold, as explained by George Coghill: the distance of Mount Buffalo from Melbourne, and the character of the country (Coghill 1904). But Charles Walter's account of his visit, read before the Club by Charles French, Jnr on 10 July 1899, changed all this. The combination of this paper, the urging by J.H. Maiden that every Victorian botanist should visit the Alps (Maiden 1900), and the timely invitation of Gustav Weindorfer to join him on a short holiday led to the visit of F.G.A. Barnard and C.S. Sutton at Christmas 1902. Impressed by the scenery, the wealth of the alpine flora and the geological interest, they reported their experiences to the Club on 9 March 1903 (Barnard and Sutton 1903). J. Shepherd suggested that the Club should bear this locality in mind for an extended excursion (FNCV 1901-1907, year 1903).

Inquiries were made, and it was found that the difficulties and costs were not as great as had been anticipated. So, on 24 December 1903 a party of 22 Field Naturalists left from Spencer Street station on what was to prove a highly successful expedition. The FNCV had always been keen to include ladies in its activities, and indeed it was held by one Secretary to be an important factor in the continuing existence of the Club (Best 1881). George Coghill, in his account of this campout, implies that one of the doubts about this expedition was that ladies might not want to undertake so arduous a holiday. But he was proved wrong. The eleven intrepid ladies included in the party were prepared for the spartan conditions and the demands of the terrain, and coped with the vagaries of the weather. Apart from a few sprained ankles they were, like the rest of the party, 'merry withal' (Coghill 1904). As Hugh Stewart later observed, this expedition was 'a classic in the Club's history' (Stewart 1940).

Other Club visits followed, though precisely how many is unclear. The campout in 1937 is described as the third, but there is no record of the second. There had been visits by individual members in the interim. In January 1917, D.J. Paton visited the Buffalo Plateau, and in his introductory remarks to the Club in July he stated that 'fourteen or fifteen years ago this region... received some attention from members of the Club' (Paton 1917). Evidently there had been no organised visit since 1903. In 1926, L.L. Hodgson and his wife decided to spend their summer holiday on Mount Buffalo at a time, as he said, 'when maximum interest could be derived from the flora, fauna, and other natural features of the district'. Near the Government Chalet they found a 'well-blazed Eucalypt with the names 'C.S. Sutton' '... Gossier' and

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'G. Weindorfer' and the date '1903' deeply scored thereon' (Hodgson 1927). While reflecting the pioneering feeling of the early Club members, it is a practice which would be frowned upon today.

The next official visit took place over the Australia Day weekend in 1937, and was led by Hugh Stewart, who had a long association with the Buffalo Plateau, having visited it almost annually since 1919. He had exhibited, at the Club ordinary meeting in February 1936, a large number of specimens from Mount Buffalo which he had collected that January; and there is no doubt that his enthusiasm and concern for the area stimulated the Club's interest. Access was much easier than it had been in 1903. The road up the mountain had been constructed in 1908, and the Chalet in 1910. No pack-horses and tents required. 'A stroll' was taken towards Billson's Lookout and the Haunted Gorge, and in the afternoon the party made 'the seven miles motor trip to the Horn'. Hugh Stewart detailed the flora seen, including the Bogong Leek-orchid *Prasophyllum alpinum* (= *P. tadgellianum*) Rogers not previously reported from the area, and the rare Elbow Orchid *Spiculaea huntiana* (= *Arthrochilus huntianus*) which had been discovered the previous year. Mrs Blanche Miller provided a list of birds observed, including some new species for the Plateau. She mentioned the first official visit and L.L. Hodgson's visit, so it would appear that the latter's was mistaken for the Club's second visit. A warning note on conservation and preservation was sounded by Stewart, who lamented the effects of bushfires in previous years, and the fact that it was still necessary to use National Park timber for the Chalet fuel requirements (Stewart 1937).

Christmas/New Year 1938/39 saw Hugh Stewart on the Mount again, and he reported his botanical findings in *The Victorian Naturalist* in March 1939. He commented that fire and axe had taken their toll on the eucalypts and that 'the cow once more becomes the enemy of much of the dwarf growth, now grazing leases in the Park have been revived' (Stewart 1939a). His remarks, made shortly after his departure, that the mountain had escaped the bushfires which had swept the north-east of the State, unhappily, were not true, as he explained in a later note (Stewart 1939b).

The Club's next visit took place early the following year, the party including Mr and Mrs George Coghill, who had both taken part in the first expedition. The bushfires of the previous year had caused much devastation, but vigorous regrowth was noted. S.R. Mitchell provided articles on the geology and the aborigines of Mount Buffalo (Mitchell 1940a, b).

In Mountain Miniatures No 2, Stewart refers to the re-discovery of *Logania floribunda* (= *L. albiflora*) by himself and E.E. Lord in January 1950, and Stewart was there again in January 1952 (Stewart 1953), but there was a long gap before another official Club visit took place in 1978.

In contrast to the 1903 expedition, Joan Forster (1978) commented that it was 'a novelty to be waiting on a crowded station for a train journey instead of setting out by bus'. But, like the early visitors, they experienced the fickleness of the weather, with two days of heavy rain, followed by a near heatwave. At least they were spared the snow which fell on Walter's visit, when he retreated to Manfield's Temperance Hotel and occupied himself drying and arranging his specimens, a set of which he left with Mr Manfield's son 'for information of future visitors' (Walter 1899). This collection no longer exists (Fletcher 1995). Joan Forster (1978) gave a detailed account of the visit, including the flora and fauna observed, and a vivid description of the Chalwell Galleries, where they 'stretched...down narrow defiles, climbed up through crevices between boulders' proceeding 'backwards on hands and feet' at one point, then twisting themselves 'upwards through a slit between the boulders'. After 'much physical effort' they were rewarded with a view over the Buckland Valley and across to the alps beyond. The Field Naturalists had lost none of their spirit of adventure in the intervening seventy-five years, ...and no sprained ankles were reported!

The next excursion was in January 1990, when many plants and birds were observed. This visit seems to have been somewhat less strenuous than the previous one, and the weather was kinder. However, the people who set out for the

Horn returned after a deluge, 'The mist closed in... and we retreated to the warmth of the Chalet lounge...' (Parkin 1990). Very different from the experiences of the first expeditioners, who endured leaky tents, and slept on beds of logs and wire netting! In January 1995, another Field Naturalist, Ron Fletcher, followed in the steps of Charles Walter, and added some forty-five species of plants to those included in the specimens from the mountain which were exhibited by Walter at the Club's Conversazione in May 1899. No introduced species appear in his list, although St John's Wort *Hypericum perforatum* was observed in 1990 (Parkin 1990), and Barnard had commented on how widespread it was in 1903. However, this was in the valley along the road to Harrietville (Barnard and Sutton 1903). When J.H. Willis compiled a vegetation list for Mount Buffalo he recorded forty-six introduced species, but observed that it seemed 'remarkably free of weeds' (Willis 1970). To celebrate the centenary of Mount Buffalo National Park, the Field Naturalists Club of Victoria organised an Educational and Research Expedition entitled 'In the Steps of Von Mueller', in February this year.

Although the FNCV played no active part in the establishment of the Mount Buffalo National Park, from its inception it was aware of the need for vigilance. Reviewing the report on the Buffalo Mountains by E.J. Dunn, which appeared as Memoirs of the Geological Survey of Victoria No 6 in 1908, F.G.A. Barnard concluded 'we trust that in opening up tracks for tourists the Government will not lose sight of the fact that the whole plateau should be treated as a sanctuary for all indigenous animal and plant life, for which, from its position and isolation, it is admirably adapted, and before any extensive works such as making lakes for skating surfaces in winter are entered upon, a thorough examination of the area from a biological point of view should be undertaken. Unless this is done at once many of the rarer plants will disappear, and thus the mountains, which should be the showplace of our highland flora, will lose much of their charm for the nature student' (Barnard 1908).

Two years later, in 1910, an investigation of the forest resources of the Ovens Valley, including Mount Buffalo, was carried out by A.J Ewart and J.A. Audas. Though both were members of the Club, this was done in their official capacities as Professor of Botany, Melbourne University and National Herbarium botanist respectively. Hugh Stewart's booklet Flower and Feather at Mount Buffalo National Park, published by the Victorian Railways, was virtually a reprint of his article in *The Victorian Naturalist* (Stewart 1939a); and in 1970 J.H. Willis provided the Mount Buffalo National Park Vegetation List for the National Parks Authority.

The issue of a grazing licence on Mount Buffalo caused concern, and the FNCV, along with kindred societies, protested vigorously against this in 1939, without effect (Stewart 1942). In 1946, Hugh Stewart gave evidence on behalf of the Club before the Forests Grazing Committee. He said there had been a gradual depreciation of the alpine flora in the 26 years since he had first visited the park, and this had accelerated as a result of bushfires and grazing since 1939. Another concern was the pollution of the Chalet water supply due to cattle grazing on the extensive grass catchment areas (Anon. 1946). Despite protests it was another ten years before grazing licenses ceased to be issued (Webb and Adams 1998).

In 1967, another threat to the environment was posed by the proposal to create a lake in the vicinity of the Tatra Inn. On 27 April, David Lee, FNCV Secretary, sent a telegram to the Premier, Sir Henry Bolte, protesting against this, if the report in the press were true, and on 13 May issued a press release to *The Herald and Weekly Times* to the same effect. The Council of the Victorian National Parks Association held a special meeting, which was attended by the President and Secretary of the FNCV, at which it was decided that both bodies should request a meeting with the Minister for State Development and the Director of the National Parks Authority to clarify the issue. A sub-committee was duly appointed and met on 22 May 1967 to prepare a summary of the arguments for and against such a proposal. Apart from the environmental effects of such a lake, the basis of their argument was that such a

proposal was in direct contravention of the provisions of the *National Parks Act* 1958, as amended at 15 July 1965 and, therefore, the construction of the lake would be illegal (Williams 1967). The National Parks Authority Report for the year 1965, released at this time, supported this contention. In spite of this a report in *Ski Australia* April/May 1970 said Ollie Polasek (Director of Tatra Development Pty. Ltd.) was 'pushing ahead' with proposals to create the lake. In 1972, Rupert Hamer replaced Sir Henry Bolte as Premier, and a freeze was put on the entire development. Three years later when the Victorian Government announced the purchase of Tatra Holiday and Ski Resort, Ollie Polasek complained that conservationists had been 'getting at the Government' (Webb and Adams 1998).

When E.J. Dunn produced his survey of the Buffalo Mountains he called the area 'the most wonderful mountain tract within the State'. All the accounts of visits embody this sentiment: Charles Walter speaks of 'a magnificent panoramic view'; for George Coghill, the rain was not to be deplored because the mist effects in the Gorge were 'something never to be forgotten'; Ruth Parkin, delighting in the flora, says that the 'Garden of the Gods' as Dunn called it, 'best describes the hours of pleasure one can spend botanising there'; and the sense of wonder that all high places inspire infuses Joan Forster's detailed and factual account in which she speaks of trees appearing 'as twisted grey shapes in the white mist' and 'wisps of cloud' that 'creep up the mountain as in a Chinese painting'.

Acknowledgements

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FNCV Buffalo Mountains Camp-out, 24/12/1903-4/1/1904

Friday (Christmas) morning, we had breakfast before 6 o'clock, and the walkers (15 in mumber) started off in good spirits for their climb of over 3,000 feet, the riding party coming on later. ... it will be many a day before I forget my first glimpse of the 'tundra' country in front of Carlile's Hospice. Here were flowers of all colours and kinds. ... A walk of about a mile brought us to our camp, just before reaching which we got the first glimpse of the glorious views from the Buffalo Gorge into the valley below, and across to Bogong, with Kosciusko in the distance. The camp was within fifty feet of the edge of the Gorge, and consisted of a slab hut, in which seven ladies slept, a canvas tent-house for eight men, a dining tent, two of Mr Mattingley's bell tents, and two small tents ...Long will we all remember that New Year's Eve, with its impromptu programme of songs and recitations, a charade, the re-incarnation of the Buffalo and the Haunted Gorge ghost, speeches, singing of "Äuld Lang Syne", and supper.

G. Coghill, *The Victorian Naturalist* **20**, 1904, 144-159.

The Scientific Value of Mount Buffalo National Park

by Malcolm and Jane Calder[1]

'Knowledge Itself is Power'

In 1597, at the age of 36, Francis Bacon observed that 'knowledge itself is power'. The driving power for effective management of Mount Buffalo National Park (or for that matter any piece of land) is surely knowledge, an understanding of the environmental and biological factors which interact in complex ways to produce and maintain particular ecosystems. Those who have the responsibility for the management of national parks obtain their knowledge from a range of sources of which scientific research is a primary component. Of course there are other sources of knowledge such as experience, history and the understanding that comes from familiarity with the particular environment. This accumulated knowledge provides the power base for management, taking into account also the constraints and policies superimposed by governments and management authorities.

Scientific research is absolutely essential for the ecologically sensitive and effective management of our national parks, and in our national parks we have a resource pool of near-natural environments which can not only tell us much about the original Australia but also provide insights into the effective management of our parks. In 200 years we have transformed most of the country, using land culture systems developed for the management of land in the northern hemisphere and on the other side of the world, but our climates, soils and ecological systems are different and many systems have not responded well to the imposed regimes. By detailed ecological studies of truly Australian ecosystems, we may obtain greater insights into the best methods for long term land management and sustainable development, not only for the management of native ecosystems, but also for the survival into the future of our primary industries and our society. Ecological knowledge is the power by which we will survive on this island continent.

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The importance of scientific research and information is recognised in Victoria's National Parks Act, 1975. Included in the Objects of the Act is the following clause:

> '*for the study of ecology, geology, botany, zoology and other sciences relating to the conservation of the natural environment [within parks]*'.

These words of the Act, linking study and research with conservation management of the natural environment as a required function within parks, are unequivocal. Parliament and the people understand the words. No other course of action, or inaction, is acceptable. The Mount Buffalo Management Plan identifies a number of potential research and monitoring projects which could have beneficial outcomes for the future of the park. A question remains as to how these projects themselves are monitored - by Parks Victoria, by Parliament, or by interested outsiders?

Mount Buffalo National Park

Geology and landscape

Today, Mount Buffalo National Park stands as a massive, granitic mountain range rising to 1723 m above sea level, clothed in eucalypt-dominated forests. It has not always been so. The history of Mount Buffalo starts some 390 million years ago when white-hot magma was intruded deep into the overlying Ordovician sediments. This magma cooled slowly and the crystals of quartz, feldspars and mica grew large. The granite massif is now exposed, following periodic uplift and the erosion of the overlying softer sediments. The intense heat of the magma caused some metamorphism and hardening of the sediments above and to the side of the contact zone and these metamorphic rocks now form the basis of the hills which lie at the foot of the plateau.

Flora and Vegetation

There are several different vegetation communities within Mount Buffalo National Park; 24 plant species are recognised as Rare,

Vulnerable or Endangered; and three of these species (Buffalo Sallow Wattle[#], Fern-leaf Baeckea and Buffalo Sallee) are endemic to the Park. In the Proposed Management Plan for the Park (1992), the Department of Natural Resources and Environment lists a total native flora in excess of 550 vascular plants and recognises the following eight broadly distinct vegetation types within the park.

Grasslands. On the Plateau, grassland communities are widespread along the drainage lines and the cold air drainage basins, such as Camp Plain, Hospice Plain, Kowan Plain and Lyrebird Plain. These communities are dominated by Soft Snow-grass together with a range of herbaceous species including, Scaly Buttons, Yam-daisy, Granite Buttercup and Purple Violet.

Wetland communities. These are found along the permanent drainage lines and shallow basins on the Plateau. Sedges, tend to dominate with Silver Astelia, Alpine Baeckea, Silvery Snow Daisy, Spreading Rope-rush, Candle Heath and others. Sphagnum Moss is a natural component of most of these communities, although in places degeneration is obvious and is attributed by Rowe (1970) to a progressive lowering of the water table resulting from stream entrenchment.

*Sub alpine dry heath*s. These communities are found on the better drained sites and the dominant species vary according to the specific location. Leafy Bossiaea and Rusty Pods generally are found between the grassland and sub-alpine woodland; Yellow Kunzea dominates on the low rises in the grassy plains where it forms low closed heathland. On rocky sites Mountain Plum-pine may dominate as a Closed Heathland.

Subalpine woodlands. Subalpine woodlands are a feature of the Buffalo plateau, as they are of much of the high country of Victoria. Here they are dominated by Snow Gum and Mountain Gum with a shrubby understorey of the different heathland species, as well as several different tussock grasses. Localised populations of the Mount Buffalo Sallee are a component of these subalpine woodlands.

[#]Scientific names are given in the list at the end of the paper.

Montane forests. On slopes between 900–1400 m elevation and on the plateau where deeper soils can be found, montane forests are dominated by pure stands of Alpine Ash. On drier or more exposed sites, or where soil depth is minimal, Mountain Gum dominates. All these communities have a shrubby understorey, with ferns and herbaceous species in the wetter areas.

Moist open forests. From the lowest elevations in the Park up to 915 m, Narrow-leaf Peppermint is the common component of moist open forests. They occur on southerly aspects of the gentler slopes and in protected gullies. Along streams and in wet gullies they are often associated with Manna Gum, although Mountain Swamp Gum is found on the less well drained sites. Candlebark is also found in this community as well as Bogong Gum at higher elevations. The shrub layer is well developed and tussock grasses are a feature of the ground cover.

Dry open forest. This occurs on the dry northerly and westerly aspects of steep slopes, mainly on the metamorphosed sediments of the foothills. Red Stringybark and Broad-leaved Peppermint are co-dominants with Long-leaf Box scattered throughout. The shrub stratum is generally sparse and there is little ground cover other than canopy litter and patches of Austral Bracken.

Montane dry heath. This community occurs adjacent to the mid elevation granite outcrops and is dominated by Myrtle Teatree. Violet Kunzea, Lemon Bottlebrush, Common Fringe-myrtle and Buffalo Sallow-wattle may be found with tussocks of Saw-sedge. Variable Sword-sedge, Scrambling Coral-fern and scattered trees of Brittle Gum are more common on the wet drainage patches in this community.

Fauna

These different vegetation types give rise to a diverse array of habitats for native animals. The severe climate and exposure of the Plateau seem to be associated with a rather limited range of species and there is a notable difference in species number between summer and winter. Some birds and insects undergo altitudinal migrations, moving onto the Plateau in the summer. Thus there is a distinct seasonality to the distribution and activity of the animals within Mount Buffalo National Park.

The Dusky Antechinus and Bush Rat remain on the Plateau all year, taking shelter under the snow in crevices and holes in the rocky outcrops. The snowgum woodlands provide round-year food and shelter for the Agile Antechinus, the Common Wombat and the Short-beaked Echidna. Within the canopy the Common Ringtail Possum can be located at almost all times of the year.

Reptiles and bats survive the winter on the Plateau in a state of hibernation but in summer the Alpine Copperhead and the White-lipped Snake can be seen along with Grass and Water Skinks and several species of frog. The Mountain Dragon is common around open, rocky areas in the warmer months. There are several native fish species of significance within the Mount Buffalo National Park. The Mountain Galaxias has been seen in remote streams on the Plateau and there are unconfirmed reports of the Flat-headed Galaxias. Galaxias may well compete unsuccessfully with the introduced Brown Trout which is now widespread within the Park. The native Trout Cod, an internationally recognised endangered species, has been introduced at two sites on Buffalo Creek where the habitat has been identified by the Department as suitable. Monitoring of these introductions should be undertaken to assess the success or otherwise of the programme.

There are, of course, many insects recorded from the Buffalo Plateau, probably the most notable being the Bogong Moth which migrates from the lowlands to the north and gathers in huge numbers, clustered in crevices and caves during the summer months. On the grassy plains Wolf Spiders are very common in the summer and there are many butterflies and beetles to be seen at this time of year.

Winter-resident birds include the Australian Raven, Crimson Rosella, Grey Currawong, Pied Currawong and the Grey Shrike-thrush and these can be seen on the Plateau all-year-round. Summer visitors include the Yellow-faced and White-eared Honeyeater, Brown Thornbill, White-browed Scrub-wren, Scarlet and Flame Robin and the Spotted Pardalote. In warmer months the Superb Lyrebird frequents the woodlands of the Plateau.

Passing down from the Plateau the range of animal species increases and includes the Swamp Wallaby, Long-nosed Bandicoot, Brushtail Possum and both the Sugar and Greater Glider. The lower forests are also home to the Yellow Robin, Grey Fantail, White-throated Tree-creeper, Kookaburra, Yellow-tailed Black Cockatoo and Gang Gang Cockatoo.

The biodiversity of reptiles also increases at these lower altitudes, especially near rocky outcrops, and includes the Black Rock-skink, White Skink, Blotched Blue-tongue Lizard and both the Tiger and Brown Snake.

The Scientific Significance
The Granite Island

Mount Buffalo National Park is a relatively isolated area of upland and subalpine country in near-natural condition and, because of its separation from the main block of high country to the south, there are several aspects of its geology, natural history and biodiversity which give it great scientific significance. What is its origin, how was it formed? In one sense it is part of the Victorian high country with its surrounding foothills and valleys, yet it is different. Costermans (1981) refers to it as an 'Island Plateau', and its isolation increases markedly its scientific interest. While physically discrete, is it biologically distinct?

Biodiversity Protected

Mount Buffalo is perfectly situated and structured to investigate the dynamics of plant and animal populations in relation to the influence of topography, aspect and altitude. It is an open air laboratory for the study of seasonal and altitudinal migrations of native animals. Geographic isolation is recognised as a powerful factor in the evolution of plant and animal species; to what extent does the biota of sub-alpine Mount Buffalo provide information on biological evolution in Australia? In particular, studies on the population biology, genetic variation and evolution of the species endemic to Mount Buffalo could lead to further insights into the evolutionary dynamics of Australian plants and animals.

Since the first botanical expedition to Mount Buffalo was undertaken by Ferdinand von Mueller in 1853, there have been periodic reports on both the flora and fauna of the Park. There are well over a

century of records and observations - many reported in *The Victorian Naturalist* - which could be used as a basis for investigations relating to the questions posed in this paper. From the point of conservation management within a park which has high recreational and tourist use, Mount Buffalo is the ideal laboratory. All that is needed is the will to do it; the realisation of the value of this work for the future management of the park; and the financial resources to plan, execute and report on the findings in a way which is relevant to the management of the Park. A resource of particular interest is a small herbarium of plants collected and identified by P.R.H. St John of the Royal Botanic Gardens, Melbourne, in the 1930's and now housed in a couple of filing cabinets in the Mount Buffalo Chalet.

Climate Change

While the world community debates the reality or otherwise of man-induced climatic warming, it is possible that real evidence could be provided through detailed studies of long-term changes in the distribution or behaviour of plants and animals on the slopes of the Mountain.

The People Component

In the two hundred years of settlement in Victoria, Mount Buffalo and its Plateau have been subjected to a range of activities including grazing, timber production and recreation in the form of walking, downhill and cross-country skiing, camping, horse riding, rock climbing, hang gliding and the like. Tourist accommodation is provided at The Chalet and at Mount Buffalo Motel. All these activities and facilities are supported by high quality road access, on-mountain water supplies and sewerage treatment. In recent years snow-making operations have been undertaken and bush walking has become more popular.

There could be no better location in Victoria to study the impact of human activity and investigate the concept of 'carrying capacity' in a natural area than the plateau of Mount Buffalo. This generation of Victorians has a responsibility to use the scientific method to provide the information which managers need in order to protect the environment, while at the same time providing the best quality information to facilitate effective and sensitive management outcomes.

Concluding remarks

The scientific value of Mount Buffalo national park is limited only by our capacity to identify the many environmental, evolutionary and managerial questions which need to be answered for the success of its ongoing management; and by the failure of the wider community (including politicians) to understand the critical importance and relevance of research in the overall management and enjoyment of the environment. Judging by the steady fall in the level of funding for scientific research in Victoria, scientists have failed to persuade or convince the communities they serve of the critical value of well researched information. To use an economic analogy, research results and research infrastructure are the capital assets of scientific endeavour. Earlier this century, science was supported strongly by both Victorian and Australian governments as well as by the community at large, as evidenced by the foundation and funding of the Commonwealth Scientific and Industrial Research Organisation, and in Victoria through the research activities and Institutes of the Department of Agriculture, the Lands Department and the different arms of the Department of Conservation. Research results (intellectual property) and research infrastructure are major capital assets of our civilisation and the strength of our conservation land management, farming and rural industries reflects this earlier investment.

In recent times these assets have been reduced dramatically and to a level where research viability is dangerously threatened. Even in recent months (April 1998) we have heard of the threatened closure of several prime research facilities in the State; including Institutes where environmental studies have been the principal responsibility. The future management of Mount Buffalo National Park as well as the other parks in our national park system is dependent on this objective scientific research. It must be be concluded, that our political decision makers are completely ignorant of the value of science and do not understand the drastic consequences of a rundown in the capital value of our research capability. We face challenging times!

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A list of the Mount Buffalo plants and animals mentioned in the text

Plants

Bracken, Austral *Pteridium esculentum*
Coral-fern, Scrambling *Gleichenia microphylla*
Rope-rush, Spreading *Empodisma minus*
Sedge *Carex gaudichaudiana*
Snow-grass, Soft *Poa hiemata*
Sphagnum Moss, *Sphagnum cristatum*
Sword-sedge, Variable *Lepidosperma laterale*

Ash, Alpine *Eucalyptus delegatensis*
Astelia, Silver *Astelia alpina*
Baeckea, Alpine *Baeckea gunniana*
Baeckea, Fern-leaf *Babbingtonia crenulata*
Bossiaea, Leafy *Bossiaea foliosa*
Bottlebrush, Lemon *Callistemon pallidus*
Box, Long-leaf *Eucalyptus goniocalyx*
Buttercup, Granite *Ranunculus granitifolia*
Buttons, Scaly *Leptorhynchos squamatus*
Candlebark *Eucalyptus rubida*
Daisy, Silvery Snow *Celmisia asteliifolia*
Fringe-myrtle, Common *Calytrix tetragona*
Gum, Bogong *Eucalyptus chapmaniana*
Gum, Brittle *Eucalyptus mannifera*
Gum, Manna *Eucalyptus viminalis*
Gum, Mountain *Eucalyptus dalrympleana*
Gum, Snow, *Eucalyptus pauciflora*
Heath, Candle *Richea continentis*
Kunzea, Violet *Kunzea parvifolia*
Kunzea, Yellow *Kunzea muelleri*
Peppermint, Broad-leaved *Eucalyptus dives*
Peppermint, Narrow-leaved *Eucalyptus radiata*
Plum-pine, Mountain *Podocarpus lawrenciana*
Rusty-pods *Hovea montana*
Sallee, Mount Buffalo *Eucalyptus mitchelliana*
Stringybark, Red *Eucalyptus macrorhyncha*
Swamp-gum, Mountain *Eucalyptus camphora*
Teatree, Myrtle *Leptospermum myrtifolium*
Violet, Showy *Viola betonicifolia*
Wattle, Buffalo Sallow *Acacia phlebophylla*
Yam Daisy *Microseris lanceolata*

Animals

Birds
Black Cockatoo, Yellow-tailed *Calyptorhynchus funereus*
Cockatoo, Gang Gang *Callocephalon fimbriatum*
Currawong, Grey *Strepera versicolor*
Currawong, Pied *Strepera graculina*
Fantail, Grey *Rhipidura fuliginosa*
Honeyeater, Yellow-faced *Lichenostomus chrysops*
Honeyeater, White-eared *Lichenostomus leucotis*
Kookaburra *Dacelo novaeguineae*
Lyrebird, Superb *Menura novaehollandiae*
Pardalote, Spotted *Pardalotus punctatus*
Raven, Australian *Corvus coronoides*
Robin, Flame *Petroica phoenicea*
Robin, Scarlet *Petroica multicolor*
Robin, Yellow *Eopsaltria australis*
Rosella, Crimson *Platycercus elegans*
Shrike-thrush, Grey *Colluricincla harmonica*
Scrubwren, White-browed *Ericornis frontalis*
Thornbill, Brown *Acanthiza pusilla*
Treecreeper, White-throated *Ormobates leucophaeus*

Mammals
Antechinus, Agile *Antechinus agilis*
Antechinus, Dusky *Antechinus swainsonii*
Bandicoot, Long-nosed *Perameles nasuta*
Echidna, Short-beaked *Tachyglossus aculeatus*
Glider, Sugar *Petaurus breviceps*
Glider, Greater, *Petauroides volans*
Possum, Common Ringtail *Pseudocheirus peregrinus*
Possum Brushtail *Trichosurus vulpecula*
Rat, Bush, *Rattus fuscipes*
Wallaby, Swamp, *Wallabia bicolor*
Wombat, Common *Vombatus ursinus*

Reptiles
Blue-tongue Lizard, Blotched *Tiliqua nigrolutea*
Copperhead, Alpine *Austrelaps superbus*
Dragon, Mountain *Tympanocryptis diemensis*
Rock-skink, Black *Egernia saxatilis*
Skink, Grass *Lampropholis quichenoti*
Skink, Eastern Water *Eulamprus quoyii*
Skink, White's *Egernia whitii*
Snake, Eastern Brown *Pseudonaja textilis*
Snake, Tiger *Notechis scutatus*
Snake, White-lipped *Drysdalia coronoides*

Fish
Trout, Brown *Salmo trutta*
Galaxias, Flat-headed *Galaxias rostratus*
Galaxias, Mountain *Galaxias olidus*
Trout Cod *Maccullochella macquariensis*

Insects
Moth, Bogong *Agrotis infusa*

Special Protection Zone Management within Mount Buffalo National Park

Allison Marion[1]

Abstract

Mount Buffalo National Park contains some of Victoria's most significant plant communities. Park managers have the challenge of ensuring that Mount Buffalo's flora and fauna is protected and enhanced for future generations, whilst still providing for the many different recreational uses. Special Protection Zones have been established within the Park to ensure the unique natural or cultural values are given additional protection. Research and monitoring programs are being developed and implemented to ensure that Mount Buffalo maintains its rich values. (*The Victorian Naturalist* **115** (5), 1998, 169-174).

Introduction

Mount Buffalo National Park is one of Victoria's oldest national parks, celebrating its centenary in 1998. The park is renowned for its spectacular scenery, many walking tracks and diversity of recreational activities. To a botanist or naturalist the park offers over 550 plant species, three of which are endemic, and a diversity of fauna species (Natural Resources and Environment (A) 1996).

The plateau has plant species and communities of high botanical significance. Two communities that are listed as threatened on the *Flora and Fauna Guarantee Act* 1988 occur in the park: Alpine Bog Community and Fen (Bog) Pool Community (Natural Resources and Environment (A) 1996). There are twenty-one rare or threatened flora species, and one species is listed on the *Flora and Fauna Guarantee Act* 1988 - the Clustered Kerrawang *Rulingia dasyphylla* (Natural Resources and Environment (A) 1996).

Little information is known about the distribution, types and abundance of the park's fauna species (Natural Resources and Environment (A) 1996). There are two species listed on the *Flora and Fauna Guarantee Act* 1988 that have been confirmed in the park: Bluenose Cod *Maccullochella macquariensis* and Spotted Tree Frog *Litoria spenceri* (Natural Resources and Environment (A) 1996). Another species, Spotted-tailed Quoll *Dasyurus maculatus* is listed on the *Flora and Fauna Guarantee Act* 1988 and may occur in the park, but its presence has not yet been confirmed (Natural Resources and Environment (A) 1996). The butterfly Alpine Silver Xenica *Oreixenica latialis theddora* is believed to be endemic to Mount Buffalo (Natural Resources and Environment (A) 1996). In total there are at least nine species of confirmed and unconfirmed sightings of rare or threatened fauna species (Natural Resources and Environment (A) 1996).

Given this brief insight into the value of Mount Buffalo's flora and fauna, Rangers have a responsibility to ensure that these unique species are protected and enhanced for future generations and that genetic diversity is maintained. To achieve these outcomes, different management zones (such as Special Protection Zones) have been created within the park.

This paper looks at what Special Protection Zones are, what species they protect, and how they are managed.

Special Protection Zones

Special Protection Zones are areas set aside within the park to protect natural or cultural assets and, where possible, to enhance these features (Natural Resources and Environment (A) 1996). They may contain important flora and fauna species, plant communities or wildlife habitats, or be sites of historical, archaeological, geological or landscape value.

A Special Protection Zone area acts as an overlay on any other park management zone. For example if Buffalo Mint-bush *Prostanthera monticola*, a rare plant, was discovered to be growing in the vicinity of Lake Catani, which is currently classified as a Recreation and Development Zone, a

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Special Protection Zone can be implemented as an overlay. Protection will then be given to *Prostanthera monticola* in addition to the needs of the Recreation and Development Zone. This system is flexible enough to continually implement protection for note-worthy sites as our knowledge increases.

Why do we need Special Protection Zones within a national park?

Mount Buffalo National Park has over 250,000 visitor days per year. The park provides for a diverse range of activities and uses, from passive and extreme recreational pursuits through to commercial operations and areas for accommodation. With such high visitation and so many uses occurring within the park it is important to identify and protect significant areas. By establishing Special Protection Zones, managers can direct visitors away from sensitive areas, thus avoiding conflicting park uses, and can plan future management actions, such as where a new walking track might be established.

Existing Special Protection Zones

Currently the *Mount Buffalo Management Plan, 1996* states that 0.5 % (134 ha) of the park has been reserved into Special Protection Zones. There are nineteen Special Protection Zones established today (Table 1). However, the number is continually increasing as new sites are identified. Each zone may contain more than one species or aspect of significance (Table 2).

Brief description of flora and fauna species

Fern-leaf Baeckea *Babbingtonia crenulata* is one of three plant species endemic to Mount Buffalo (Natural Resources and Environment (A) 1996). The species is considered to be rare Nationally and vulnerable in Victoria (Natural Resources and Environment (B) 1996). Currently it is not listed on the *Flora and Fauna Guarantee Act* 1988 (Natural Resources and Environment (B) 1996).

Babbingtonia crenulata appears to be restricted to streams and soaks (Costermans 1992). It is found in four separate locations: along Eurobin Creek; along Buffalo Creek; along a tributary of Buffalo Creek and along the Mount Buffalo Tourist Road (*pers. obs.*).

Buffalo Sallow Wattle *Acacia phlebophylla* is rare both nationally and in Victoria (Natural Resources and Environment (B) 1996). It is also endemic to Mount Buffalo (Walsh and Entwisle 1996). The species has not been listed on the *Flora and Fauna Guarantee Act* 1988 (Natural Resources and Environment (B) 1996).

Acacia phlebophylla prefers to grow on rocky outcrops, between 500–1370 m (*pers. obs.*). Sites are exposed and have very shallow soils (Costermans 1992). *Acacia phlebophylla* has been placed into two Special Protection Zones, the first being above Rollason's Falls and the second in the Mackey's Lookout/Gorge area. Sightings of the species have been recorded at Eurobin Falls and Mollison's Galleries (Massingham 1995 *unpubl.*).

Buffalo Sallee *Eucalyptus mitchelliana* (Pl. 4C). This particular species of Eucalypt is considered to be rare both nationally and in Victoria (Natural Resources and Environment (B) 1996). It has not been listed on the *Flora and Fauna Guarantee Act* 1988 (Natural Resources and Environment (B) 1996).

Table 1. Breakdown of the Special Protection Zones established to date. Number = number of Special Protection Zones.

Number	Description
1	Flora and fauna
2	Fauna
4	Aboriginal
12	Flora
Total 19	

Table 2. Zone number and species/type protected.

Zone	Species/Type
1	*Acacia phlebophylla, Babbingtonia crenulata, Litoria spenceri*
2-3	*Babbingtonia crenulata*
4	*Acacia phlebophylla, Babbingtonia crenulata*
5	*Pratia gelida*
6-10	*Prostanthera monticola*
11	*Eucalyptus mitchelliana*
12	*Eucalyptus mitchelliana, Prostanthera monticola*
13	*Eucalyptus mitchelliana*
14-16	Archaeological site
17	*Oreixenica latialis theddora*
18	*Mastacomys fuscus*
19	Archaeological site

Eucalyptus mitchelliana is endemic to Mount Buffalo where it appears to be restricted to three separate populations: the Chalet Gorge precinct; Back Wall area and Mount McLeod (Walsh and Entwisle 1996; Lawler *et al.* 1997; Massingham 1996 *unpubl.*). The species prefers to grow in shallow soils in exposed situations, often with northerly aspects (Lawler *et al.* 1997).

Snow Pratia *Pratia gelida* is considered to be rare in Australia and vulnerable in Victoria. It has not been listed on the *Flora and Fauna Guarantee Act* 1988 (Natural Resources and Environment (B) 1996).

The habitat range of this species is rare and restricted (Natural Resources and Environment (B) 1996). It grows in subalpine and alpine environments, on bare, seasonally saturated peat soils (Massingham 1995 *unpubl.*; *pers. obs.*). It has been recorded as growing in the Alpine National Park and on Mount Buffalo (Natural Resources and Environment 1998). However, it is possible that it only occurs on the Buffalo plateau (N. Walsh *pers. comm.* 1998). The most recent records are from the Mount Buffalo Plateau.

On Mount Buffalo, *P. gelida* is found on Blackfellows Plain, Hospice Plain and Wirbill Plain (Massingham 1995 *unpubl.*).

Buffalo Mint-bush *Prostanthera monticola* (Fig. 1; Pl. 2F). In Victoria, this species probably only grows on Mount Buffalo, and in other states its distribution is also restricted (Natural Resources and Environment (B) 1996). I have located it across most of the Mount Buffalo plateau. The species is rare nationally and in Victoria (Natural Resources and Environment (B) 1996). It has not been listed on the *Flora and Fauna Guarantee Act* 1988 (Natural Resources and Environment (B) 1996).

Spotted Tree Frog *Litoria spenceri* is an endangered species in Victoria and is listed both on the *Flora and Fauna Guarantee Act* 1988 and *Endangered Species Protection Act, 1996.*

Litoria spenceri is now believed to be extinct on Mount Buffalo, as the last sighting of the species was in 1983 at Rollason's Falls (G. Johnson 1997 *pers. comm.*). *Litoria spenceri* requires boulders and debris beside fast flowing mountain streams and stream side vegetation for shelter and basking (Robertson *et al.* 1996).

Broad-toothed Rat *Mastacomys fuscus* is considered to be rare in Victoria, where it occupies high rainfall areas (Menkhorst 1995). It has very specific habitat requirements including: a mean rainfall above 1000 mm (often greater than 1400 mm) and vegetation comprising a dense ground layer of grasses, sedges and herbs (Menkhorst 1995). It has not been listed on the *Flora and Fauna Guarantee Act* 1988.

In 1990 predator scat analysis revealed the presence of *M. fuscus* within the park. However, since that time there has been no other record of the species in the park (Natural Resources and Environment (A) 1996).

Alpine Silver Xenica *Oreixenica latialis theddora* is a butterfly endemic to Mount Buffalo (Pl. 5B, 6A). Little information is available on this species (Natural Resources and Environment (A) 1996). It is not listed on the *Flora and Fauna Guarantee Act* 1988.

On Mount Buffalo the species has been identified in the vicinity of Lake Catani, where it is thought to utilise wet boggy areas and Snow Grass plains (Holmes and Holmes 1990). The species may occupy a very restricted habitat type. If so, then its presence may be an indicator of the health of the environment (I. Endersby *pers. comm.* 13 March 1998).

Fig. 1. Buffalo Mint-bush *Prostanthera monticola* growing along the Gorge Heritage Walk.

The planning process

If an area contains aspects that meet the criteria of a Special Protection Zone then the site is surveyed. If the Special Protection Zone is established to protect flora species, a VROT Pop (Victorian rare or threatened plant populations) form is filled in. This form gives details of the species, locality, population size and structure, threatening processes, vegetation structure and recent management activities. The forms are then lodged with the Department of Natural Resources and Environment, Flora and Fauna Branch, to be entered into the Flora Information System.

Maps are developed to outline the area to be protected. Most mapping is based on field survey data and, where possible, aerial photography is used. Similar maps of weed infestations, park boundaries and fire histories can be overlaid to determine site history and future threats. Mapping of new areas is continuous as new Special Protection Zones become established for *Flora and Fauna Guarantee Act* species and communities.

Action statements are then developed for each zone outlining the locality, significant feature or features, and giving a brief description of the feature's identification, requirements and conservation status. Details of any threatening acts or processes are recorded and management actions proposed. The action statements are updated regularly as new information on the site becomes available.

The information gathered is incorporated into Parks Victoria's Environmental Information System, which allows users to access state-wide data including the Flora Information System and Wildlife Atlas. The Environmental Information System allows Rangers to add new data, map plant locations and develop appropriate management actions for both now and the future.

Threats to Special Protection Zones

Natural processes:

Weed invasion, particularly around the park boundary, is a threat to many native plant species. Two species, Blackberry *Rubus* sp. and Himalayan Honeysuckle *Leycesteria formosa*, are prominent in the wet gullies in the park's foothills (*pers. obs.*). Both species are very invasive and will out-compete and smother native plant species. Blackberry is threatening a population of *Babbingtonia crenulata* plants growing along Eurobin Creek within Special Protection Zones two and three (Fig. 2). The degree of infestation is high and the priority for this zone is to eradicate Blackberry without damaging *B. crenulata* plants. Although spraying of Blackberry using Brush-off has occurred in the past, the effects that chemicals have on *B. crenulata* are unknown. On the plateau weed infestations are less pronounced.

Wildfires may be either advantageous or detrimental. *Eucalyptus mitchelliana* may require fire to establish itself and spread (Lawler *et al.* 1997). In the absence of fire, *E. mitchelliana* may be out-competed by Snow Gum *E. pauciflora* (Lawler *et. al.* 1997). Thus, inappropriate fire regimes could be less beneficial. Fires are generally infrequent in wet bogs and gullies of subalpine and alpine environments. However, should fire occur, it can influence the survival of a species, for example *Pratia gelida* would almost certainly be killed by frequent fires (Massingham 1995 *unpubl. data*). If fire was to destroy streamside vegetation along Buffalo Creek, then *Litoria spenceri* would decline due to a lack of shelter (Robertson *et al.* 1996).

Severe drought or flooding could harm individual plants, although to survive *P. gelida* requires wet boggy areas that are seasonally inundated (Massingham 1995 *unpubl. data*). Long periods of drought could alter the limited habitat area available for this species (Massingham 1995 *unpubl. data*). *Prostanthera monticola* and *B. crenulata* occupy creek margins, and flooding could result in plants being smothered by debris or swept downstream (*pers. obs.*).

Disease and insect attack are potentially threatening. *Acacia phlebophylla* populations have been affected by a rust fungus which forms galls, and individual plants with severe infestations have died, while others have lost considerable condition (*pers. obs.*) (Fig. 3). Gall attack appears to be the greatest threat to *A. phlebophylla* (*pers. obs.*).

Human induced threats

Human impact can be more readily managed because the cause is often easier to prevent or control, unlike natural

Fig. 2. Fernleaf Baeckea *Babbingtonia crenulata* monitoring plot showing Blackberry infestation.

processes, such as wildfire and drought, that sometimes cannot be prevented. Within each Special Protection Zone human interference is low, due to management controls.

Many rare or threatened plant species grow along walking tracks or roads, therefore track or road clearing and slashing could damage plants. This problem is prevented by ensuring that up-to-date maps and records of species locations are maintained and accessed before any works are commenced. Trampling of plants by hikers can occur, but this can be avoided by maintaining high quality walking tracks. Soil compaction can be a problem in high visitor use areas.

Deliberately lit fires can influence the survival of a species in the same way as naturally occurring wildfires. Fire prevention and control can have a damaging impact since fire may be required by some species, but not by others. Thus, by preventing wildfires the balance may be interrupted. *Acacia phlebophylla* requires some type of natural disturbance such as fire to regenerate (Natural Resources and Environment (B) 1996). To control

Fig. 3. Galls formed by rust fungus on Buffalo Sallow Wattle *Acacia phlebophylla*

outbreaks of fire, dozer lines and rake-hoe lines may be put in to protect lives or property. There is the possibility that these control lines could be put through sensitive areas, but the likelihood of this is low, due to the mapping of rare species.

With careful planning and further research work into the ecological requirements of rare or threatened species within Mount Buffalo National Park, managers can aim towards reducing the threats to Special Protection Zones. Appropriate fire management strategies can then be developed. Currently the main threats to the zones are from natural processes such as weed invasion and gall attack.

Management actions, research and monitoring

Management actions to date have focused on developing new Special Protection Zones, creating monitoring

programs and on nominating some species for listing on the *Flora and Fauna Guarantee Act* 1988. Nominations for four species have been completed and now await a decision to be made by the Scientific Advisory Committee. The *Flora and Fauna Guarantee Act* 1988 would provide additional protection for these species.

Although monitoring of these zones is in its infancy, progress has been made and monitoring programs are being developed and implemented.

Existing monitoring programs include: surveying creeks for the presence of *Litoria spenceri*; identifying and counting *Oreixenica latialis theddora* in the vicinity of Lake Catani, and the monitoring of *B. crenulata* populations along Eurobin Creek. Three plots have been established to monitor the effects of Blackberry on the growth of *B. crenulata* and to determine the best control methods.

University research and volunteers contribute to our knowledge of significant species. It is the intention of Parks Victoria staff at Buffalo to continue to encourage scientific study and, where possible, to suggest projects that would benefit both the researcher and the park.

Conclusion

The role of Parks Victoria is to balance the different park uses, and to ensure that natural and cultural values are protected. To achieve these goals Rangers need to better understand the resources they are managing through research and monitoring. Special Protection Zone management is providing the means to achieve these goals and to ensure that Mount Buffalo remains one of Victoria's finest National Parks.

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The Buffalo Mountains (Book Review)

The recent issue by the Department of Mines of Victoria, as No 6 of the 'Memoirs of Geological Survey of Victoria' of a report by the Director, Mr E.J. Dunn, FGS, on the Buffalo Mountains, splendidly illustrated with photographs of characteristic features should, as the author says, 'serve to bring into prominent notice the most wonderful mountain tract within the State... The illustrations, fifty-three in number, have been reproduced from photographs by Mr Walcott and others, and many of them are striking pictures. Mr Dunn gives the area of the granite plateau as about 13.5 square miles, being some seven miles from north to south and four across at its widest part, and when it can safely be said that almost the whole of this area is studded with 'sights'....

... We trust that in opening up tracks for tourists the Government will not lose sight of the fact that the whole plateau should be treated as a sanctuary for all indigenous animal and plant life, for which, from its position and isolation, it is admirably adapted, and before any extensive works such as making lakes for skating surfaces in winter are entered upon, a thorough examination of the area from a biological point of view should be undertaken. Unless this is done at once, many of the rarer plants will disappear, and thus the mountains, which should be the show-place of our highland flora will lose much of their charm for the nature student.

F.G.A. Barnard, *The Victorian Naturalist* **25**, 1908, 35-36.

Studies in the Structure of Mount Buffalo Granite

Noel Schleiger[1]

Abstract
A comparison of the attitude of joints, which showed a concentric and radial pattern across the area, was made between the Buffalo Granite and the folded Upper Ordovician sedimentary strata. Major joints, xenoliths and dykes were measured and mapped at 37 sites within the Buffalo Granite and at seven Upper Ordovician outcrops on the NE contact zone. The orthogonal sets of NE and NW trending joints throughout, suggest that the residual stress caused by the contraction of the cooling granite was very similar to the residual regional stress field caused by the folding of the Ordovician host rocks. It is hypothesized that the Ordovician rocks were folded in response to the Benambran (Early Silurian) Orogeny, and that the granite was intruded in the Bowning (Late Silurian) Orogeny causing the NE trending joint development. Therefore, the NW trending joints could be a third overprinting and deformation event in response to stresses of the later Tabberabberan (Late Devonian) Orogeny. (*The Victorian Naturalist* **115** (5), 1998, 175-185).

Introduction

The most striking features of the Buffalo granite are the tors, granite shelves and ledges and occasionally dykes and xenoliths*.Questions one could ask about a granite mass such as this are - what structures are present, what are the components, and how are they related?

A survey of the literature (e.g. Price 1966; Buckingham and Joshi 1978; White 1988) indicates that jointing, flow structure, dykes and xenoliths are important components of structure in a granite batholith. Therefore, measurement of the dips and strikes was undertaken to determine any predominant orientation of the jointing in tors, xenoliths and dykes of the granite and those in the Ordovician sediments.

The author, taking into account the limited amount of time and the personnel available, decided to study only the orientation of major joints, size and orientation of elongate xenoliths, and the width, lithology and orientation of dykes within the granite. As it was impossible to cover the whole plateau within the week available, it was decided to limit sampling to localities on, or astride, the Mount Buffalo Road and any of the easier walking tracks leading from it. The author designed the method for collecting/measuring the dip and strike of joints, xenoliths and dykes as well as establishing the elongation axes of xenoliths, thickness of dykes and dimensions of the xenoliths.

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Nature of the Buffalo Pluton

The Mount Buffalo granite mass is ovoid in shape with a ratio of 1.5:1, and is a very prominent feature within the Ovens Valley. It is particularly felsic, consisting dominantly of orthoclase when fresh, with quartz, biotite and muscovite. Elsewhere the rock is often kaolinised and soft enough for burrowing mammals to excavate it, as can be seen between and under tors.

Potassium argon age determinations date the granite around 400 million years b.p. Chappell and White (1974, 1984), and White (1988) regard it as distinctly older

**Tors* are piles of granite slabs standing on end according to whether the dominant joint system is horizontal or vertical. Tors are residuals left by the differential denudation of the harder and softer materials usually along joint planes by wind, water, ice and differential thermal expansion and contraction.
Xenoliths are inclusions of pre-existing rock in an igneous rock. A xenolith may be a piece of sedimentary rock which has chemically reacted with the igneous magma to become partially assimilated before crystallisation. A xenolith can also be an earlier solidified portion of the igneous rock which had a slightly different composition. A preliminary survey showed the majority of xenoliths to be of hornfels, quartzite, mica (biotite) schist and microgranite, all components found in the Ordovician sedimentary rock suggesting their origin.
Dykes are sheet-like bodies of igneous rock which are discordant, i.e. cut across the structure of the host rock. Dykes in the Mount Buffalo plateau can be either in Upper Ordovician contact rock or in the granite. Most are of aplite, but some are of microgranite, quartz, and a few are of felsite (orthoclase rich) and rarely pegmatite.

than other granite plutons in the Howqua Basement Terrane. The dominantly felsic nature of the Mount Buffalo granite suggests it is a fractionated member of the Boggy Plain Supersuite, which is independent of basement terrane boundaries, shown by other granites. (Chappell and White 1974) believe that this Boggy Plain Supersuite of granites was derived from an underplate of Ordovician rocks. The sediments in contact with the Mount Buffalo pluton are potash-rich, Hotham Group sedimentary rocks of Ordovician age and can be observed as contact rocks below the Font at 800 m and below on the Mount Buffalo Road (see Fig. 1).

Fig. 1. Contact between massive granite (right) and Upper Ordovician sediments dipping vertically to southwesterly on the Mount Buffalo Road at The Font. Ordovician sediments strike NNW and approximately parallel to the contact. Major jointing in the granite here is NNW and ENE.

Geomorphology

The geomorphology of the Mount Buffalo granite, especially the tors, has been a popular topic for the last 90 years (Dunn 1908; Brownlie and Brownlie 1979; Hills 1975). Hills (1975) refers to the extremely large tors on the Buffalo Plateau, e.g. the Leviathan, the Monolith and Cathedral Rock, and also describes the precipitous rock faces caused by the granite falling away from closely-spaced, almost vertical joints at the Gorge near the Chalet.

The Mount Buffalo Plateau comprises large areas of resistant granite whose summits are separated by more easily eroded kaolinised areas as suggested by Brownlie and Brownlie (1979) so that partial peneplains have formed on the softer material in post Cretaceous time. Today these are accentuated by the development of frost hollows at discrete levels, e.g. the Wild Dog Plains, the Lyrebird-Wirbill Plain, and the Hospice Plain at about 1300 m. On the other hand, from 1500–1723 m, large massifs of resistant granite like The Horn and The Cathedral preserve the summit relics of an earlier uplifted peneplain. Rowe (1970) recognised a plateau relic at 700–800 m on the NE flank of the Buffalo Plateau, preserved in Ordovician slates and greywacke which he described as Land Unit 5. Such summits have resisted erosion during more recent events and these features typically occur all over the Victorian High Plains.

The study aimed to discover the history of the structure of the Mount Buffalo granite as indicated by features that characterise its structure such as the joint planes**, the orientation of the minerals, and the xenoliths and the dykes within the granite. Sampling was limited to outcrops astride the Mount Buffalo Road.

To establish the development of the granite structures it was necessary to determine whether the master joints were uniform across the granite and Ordovician sediments

Fig. 2. Major jointing in massive Buffalo granite in a road cutting at 32.0, 81.3 (see grid references Fig. 3, p 177).

** *Joints* are cracks or rock fractures along which there has been **no** displacement. If a rock fracture shows displacement along it then it is a **fault**.

Joint planes: If joints in a rock are parallel or sub-parallel to each other the joints are *systematic*; if joints are confined in length to across one stratum or bed they are *minor joints*; if joints are proven to cross all or many beds in the whole outcrop, they are said to be *major joints* (Fig. 2); If the same major joints are found to occur for many hundreds of metres across many outcrops they are known as *master joints*. *Primary joints* are those whose frequency in a particular direction are the most frequent set. *Secondary joints* are the second most frequent joint set.

alike; whether the vertical major joints have the same modal directions as the flat or low dipping joints in the granite; the frequency of xenoliths in the granite - their average size and shape and whether they show preferred orientation; whether the late stage intrusive dykes were orientated at random, or showed preferred orientation, and whether the thicker dykes were orientated the same way as the thinner ones.

Methodology

The seven days of field work were undertaken from 5–13 February, 1998. Sampling was limited to the orientation (dip and strike) of joints, xenoliths, dykes (and any prominent flow structure where present) at localities astride the Mount Buffalo Road from The Horn in the south to a little beyond the National Park gate in the north. As well, five walking tracks were investigated. These were the Wild Dog Plains-Reservoir Rocky Track, Dickson's Falls Track, Chalet Road, The Hump Track and the camping area of Lake Catani. A total of 44 sites were sampled, including seven localities in the Ordovician contact rocks.

A compass-clinometer was used to measure strike and dip of every joint and dyke. Only those joints on shelves and the basal pedestals of the tors were measured. Some translation (slope creep) and rotation of tors was suspected and so joints on balancing or isolated tors were ignored.

The dip, strike and thickness of the dykes were recorded and, where possible, the length, width and thickness of the xenoliths were measured, and the trend of the horizontal surface noted. In addition the lithology of each xenolith was recorded, but most were made of hornfels.

Estimation of significance of a given joint sample

A typical sample of joints was obtained around the car park at Buffalo Lodge (formerly Tatra Inn) as set out in Table 1. If we concentrate on the steeply dipping joints (i.e. dips >45°), thereby omitting joints 13 and 14, we have a sample of 16 joint readings. The method used was that of High and Pickard (1970).

First we must make a frequency table of equal class intervals. If we aim at a **minimum** sample of 12 readings, we can subdivide the 180° range into $180 \div 12 = 15°$ sized class intervals. We then devise Table 2 where the left hand column specifies the midpoints of each strike class interval. We then mark off each strike into the class interval with the closest midpoint. Thus, joint 1 goes into the 45° strike class, joint 2 into the 135° class and so on.

Table 1. Joints on granite shelves and sections adjacent to Buffalo Lodge (Tatra Inn) car park.

No	Strike	Dip
1	40	80° SE
2	140	85° SW
3	140	88° SW
4	130	78° SW
5	50	85° NW
6	145	80° SW
7	60	65° NW
8	130	80° SW
9	5	75° E
10	130	80° SE
11	120	80° SW
12	145	80° SW
13	45	15° SE
14	40	45° SE
15	160	85° W
16	130	85° SW
17	45	55° W
18	145	80° E

Table 2. Frequencies of steeply-dipping joints in granite near Buffalo Lodge car park. (SC =Strike Class; F = Frequency tally)

SC Midpoint	F	f	f^2
0	1	1	1
15	0	0	
30	0	0	
45	3	3	9
60	1	1	1
75	0	0	
90	0	0	
105	0	0	
120	1	1	1
135	6	6	36
150	3	3	9
165	1	1	1
	$N = \Sigma f = 16$		$\Sigma f^2 = 58$

n = no. of classes = 12
N = no of joint readings.

The aim is to determine the standard deviation and mean of this distribution. The mean of $\bar{x} = 16 \div 12 = 1.33$.

To find the standard deviation which is the root mean square, we first must find the sum of squares (SS):

Sum of Squares SS $= \sum f^2 - \frac{(\sum f)^2}{N}$

$= 58 - \frac{(16)^2}{12}$

$= 36.67$

Next we find the Mean square (MS):

Mean Square MS $= \frac{\text{Sum of Squares}}{N-1}$

$= \frac{36.67}{11}$

$= 3.334$

Thirdly, we calculate the standard deviation (SD):

Standard deviation = Root Mean Square

$= \sqrt{\text{Mean Square}}$

$= \sqrt{3.333}$

$= 1.83$ (to 2 decimal places)

For a normal distribution of frequencies, there is a 5% chance that a particular frequency would exceed the mean plus two standard deviations. Such a frequency (f) must exceed $\bar{x} + 2s$.

i.e. $f > 1.33 + 2(1.83)$

$> 1.33 + 3.66$

> 4.99.

In Table 2 the 135° class does exceed 4.99 (or 5). This frequency is 6.

Therefore, we can argue that the 135° class frequency is not due to chance. There are factors other than chance producing this high frequency. We can argue that this factor is due to the directional stresses on the granite at the time of cooling.

Statistically speaking the 135° sector of joint strikes is significant at the 5% level or at $p = 0.05$, i.e. there are 5 chances in 100 that the joint frequency would exceed 4.99, and our sample is higher than this. Thus we can argue that factors other than chance have produced this result.

The magnitude of frequency of the 135° sector could be expressed as a percentage ie $6/16 \times 100 = 37.5\%$ or 38.0% (to the nearest whole number). The 135° sector is the primary joint mode for this sample.

All Locations

To illustrate the significant primary and secondary joint systems at each of the 44 localities, Fig. 3 shows the joint rosettes***. The circles represent one joint strike in each of the twelve, 15° classes.

*** a circular histogram used to display directional data.

The dominant primary mode is the NE direction, and the dominant secondary mode is the NW direction. In addition, Brownlie and Brownlie (1979) working from aerial photographs also favour the NE direction to explain the courses of Buffalo Creek, Crystal Brook and Eurobin and Bunyip Creeks. The NW direction matches the trends of the western and some eastern boundaries of the Buffalo pluton.

The joint rosettes clearly show the principal modes, but the cluttering tends to mask other trends in the joint analysis, so Fig. 4 shows the significant modal directions and summarises the major trends.

Fig. 4 is a plot of the statistically significant modes in each sample. The black circles indicate statistical significance at the $p = 0.05$ level. The white circles indicate tentative significance. Usually these distributions are bimodal, but one mode reaches significance at $p = 0.10$ level (i.e. the mode is the mean + 1.5 standard deviations).

The length of the line indicates the magnitude of the mode as does the diameter of the circle. In the NE, the strikes and dips of the Upper Ordovician sediments are shown (e.g. Locations 29–34). The interesting feature is that the Upper Ordovician strikes follow the contact zone from The Font around to Rollason's Falls.

Joints in the Upper Ordovician sediments

Examples of jointing in the Upper Ordovician rocks are shown in Fig. 5, and close to the contact with the granite in Fig. 1. The rosette, Fig. 4 (top left), is a compound figure of 103 joints from seven samples (numbers 29–34). The primary joint direction is the 50° which, in folded sedimentary rocks, is transverse to the axes of folding. In this case the average strike of the Ordovician folded strata is 145°–325°. Thus the compressive stress in the 50° direction folded the rocks on axes trending in the NW direction and produced the primary joint set in the NE direction. Fig. 4 rosette (lower right) compares the principal joint directions in the granite on cooling. It is interesting that the primary and secondary joint sets in the granite are subparallel to those in the folded Ordovician contact rocks. The primary joint sets in the granite show a swing of up

\# **Fig. 3** is taken from the map 'The Mount Buffalo Special'; 1:25,000; produced May 1983.

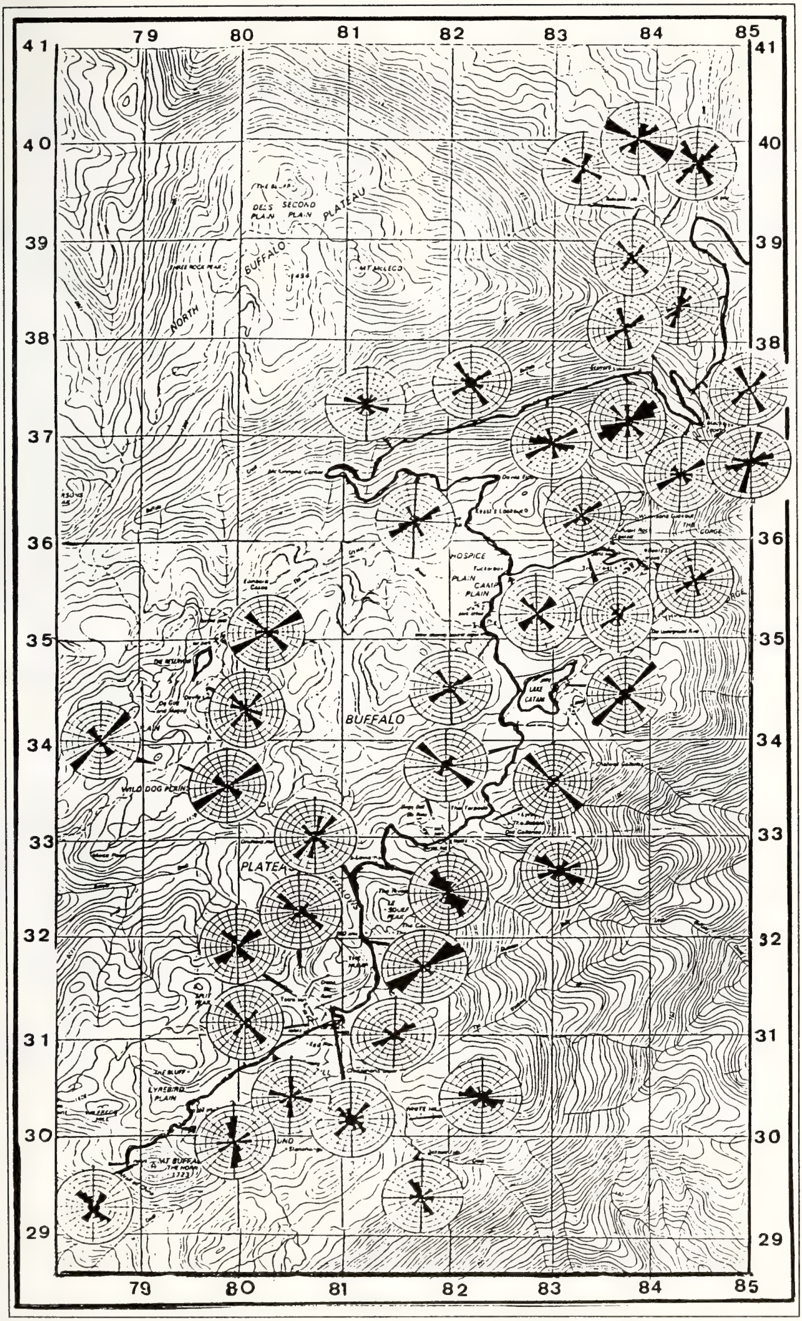

Fig. 3. Major joint directions at 44 sites over the Buffalo Plateau including seven sites of Upper Ordovician sedimentary rocks on the NE contact zone on the Mount Buffalo Road, and neighbouring tracks. Joint frequencies are represented by unit circles. Twenty three sites show a strong NE mode, and 15 sites show strong SE modes and the others, intermediate modes. Were there two deformation events, the first a NE jointing overprinted by a later SE jointing? (Refer also to Fig. 4.)

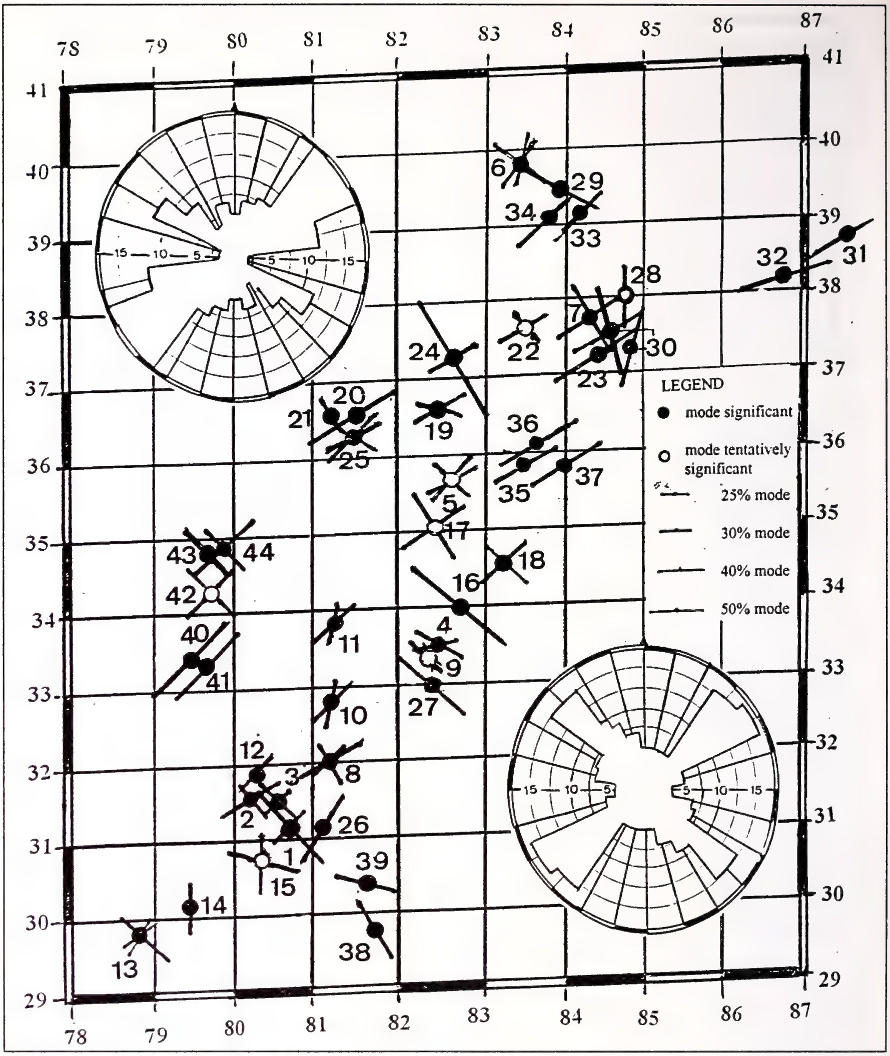

Fig. 4. Alignment of major joints in granite of the Mount Buffalo Plateau. 738 joints have been plotted on from 37 localities on granite on the rosette A at lower right. 103 joints are shown from the metamorphosed Upper Ordovician sediments on rosette B (top left). Principal modes are NE-SW for both lithologies. Secondary modes are more WNW-ESE for the Upper Ordovician and NW-SE for the Buffalo granite. The same stresses were operating from the folding of Ordovician to the crystallisation of the Buffalo granite.

to 15° compared with those of the Ordovician rocks. This could be due to a refraction of the stress field across the granite-sedimentary contact.

Xenoliths

Figs. 6 and 7 show two examples of xenoliths within the Mount Buffalo granite. Both are hornfelsic but Fig. 7 shows the aligned growth of potash felspar crystals which gives a biotite gneissic texture.

It is considered that the megacrystal growth in xenoliths indicates a more advanced stage of assimilation by the granite when it was crystallising. Rosette Fig. 8 (lower right) shows that the largest area of exposed xenoliths, although in the minority, are aligned WNW-ESE. Rosette Fig. 8 (top left) shows a trimodal distribu-

Fig. 5. Unconformity between Pleistocene boulder alluvium (above notebook), on near vertical west dipping Ordovician slates and sandstones, Dykes Lane, 200 m uphill on terrace from Mount Buffalo Road overlooking Eurobin Creek.

Fig. 6. Hornfels xenolith in granite at 32.5, 81.2 (see Fig. 3) at road level. Jointing in the hornfels is distinct from the Buffalo Granite.

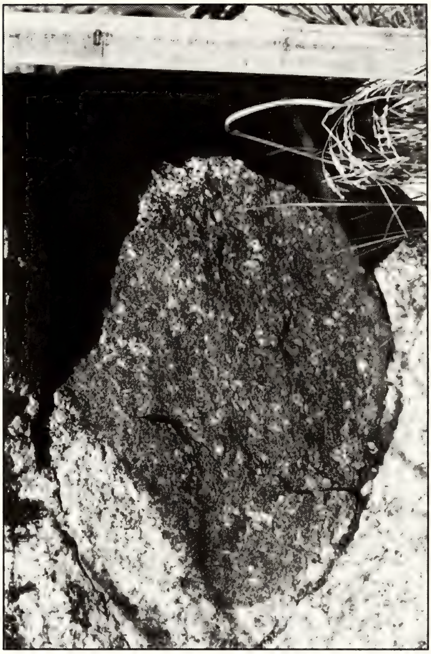

Fig. 7. Orthoclase phenocrysts showing coarse flow banding in a hornfels xenolith at 32.5, 81.2 (see Fig. 3). This xenolith has undergone more assimilation by the granite than that at top left.

Fig. 9. Aplite dyke striking meridionally and dipping 60°E stands out through partly kaolinised granite (coarse rilling). Locality 83.4, 35.8 (see Fig. 3) Chalet Road close to recreation oval.

tion, where the primary mode is NE-SW, and the secondary mode NW-SE similar to the Ordovician sediments. Does this suggest that the xenoliths rotate as they sink into, and are assimilated by, the magma? Although on Mount Buffalo, this magma, before crystallisation, shows alignment with a significant number of xenoliths, and parallels the major joint modes in the granite after its crystallisation. Foliation in the Buffalo granite is likely to be more closely allied with the jointing after the crystallisation of the granite than occurring at random. This suggests that the same directional stresses were operating both during the intrusion of the granite as well as after the granite had crystallised.

Intrusive dykes, veins and schlieren

A typical dyke is shown in Fig. 9. The dominant late stage intrusives were

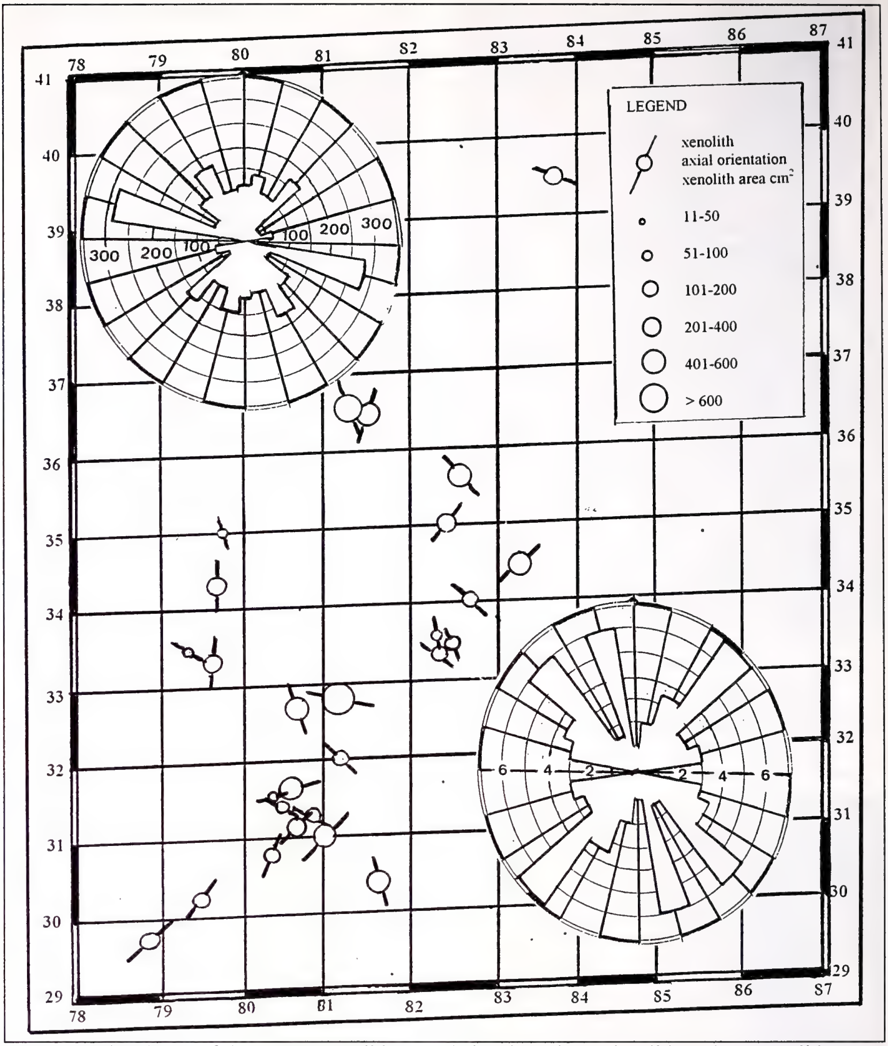

Fig. 8. Regional plot of the largest xenoliths and their orientation at localities where xenoliths were found over the study area. Most xenoliths were found in the southern and western area and indicate two blocks at least, but more searching needs to be done to validate this. Rosette at top left shows the orientation of largest xenoliths in the WNW-ESE sector. Rosette at lower right shows the frequency of alignment of the 80 xenoliths measured at all localities.

microgranite or aplite dykes. In a few localities there were some felsite dykes (orthoclase felspar) (F), rarely pegmatite (P) and occasional schlieren of quartz (Q), with felspar or biotite. Unlabelled dykes are those that dip vertically (> 85°) (Fig. 10). Only the thickest dykes are mapped at each locality on Fig. 10, and the dip, strike and thickness were measured. In the case of dykes up to one metre thick, joint directions were also measured when visible.

Fig. 10 rosette (top left) shows the thickest dykes encountered in each 15° sector. Each circle represents a 10 cm thickness increase. As shown, the thickest dykes are aligned in the NE-SW direction.

Fig. 10 rosette (lower right) shows the distribution of all dykes mapped. The primary mode is the 30° sector which is sub-parallel with the thickest dykes. The secondary set

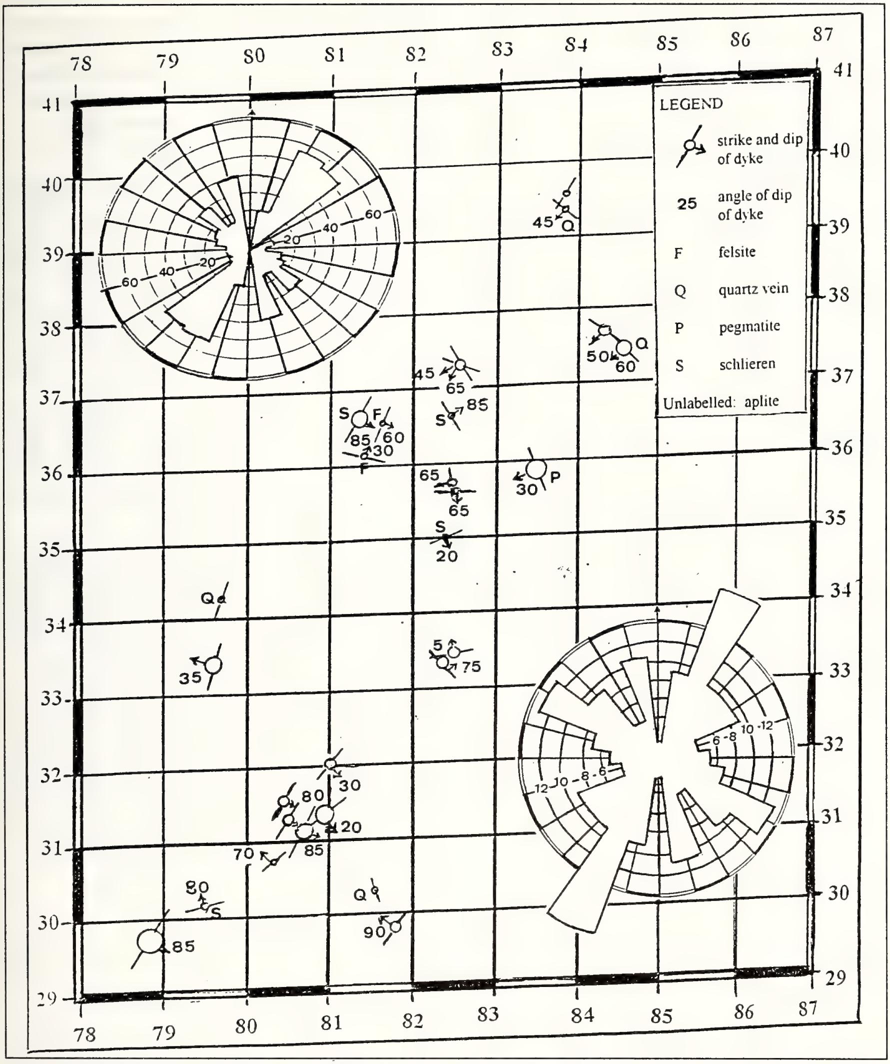

Fig. 10. Distribution of dykes and thick veins in the Buffalo granite. Except where labelled, most were aplite or microgranite. Lower right shows a rosette with percentage of dykes measured in each of 15° sectors. Each circle 2% increase. Most dykes strike in the 30°–210° sector. Top left plot is of the thickest dykes encountered in each 15° sector. Each circle increases by 10 cm. Thickest dyke was aplite 1 m thick in the NE-SW direction.

of dykes is orthogonal, trending NW-SE.

Dyke orientation indicates elongation or pull-apart of the Buffalo granite parallel to the regional strike of the Ordovician strata and to the direction of the joints in the Ordovician strata.

Steeply-dipping and low-dipping joints in the Buffalo granite

The two rosettes in Fig. 11 show a comparison of 70 low-dipping joints with 635 steeply-dipping joints from a total of 37 granite localities. Each rosette shows two dominant modes in the same directions N45°E and N45°W. (A third mode is N-S in the steeply dipping joint rosette which was recorded by Buckingham and Joshi (1978) in the Beechworth granite to the NW). One assumes therefore that the

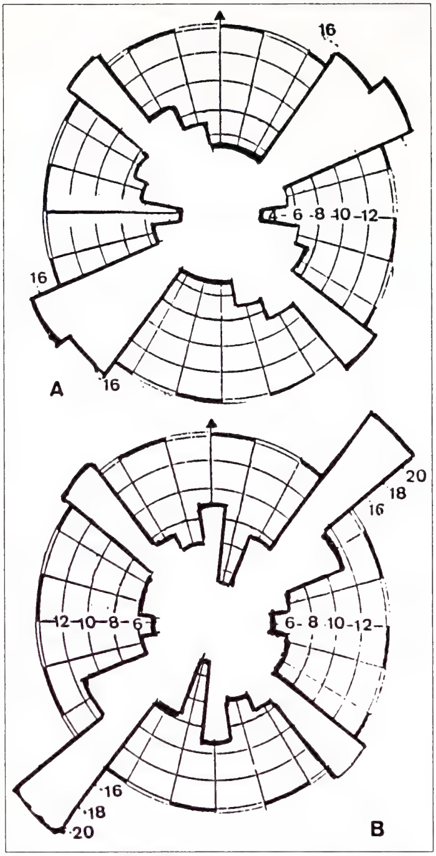

Fig. 11. Rosettes showing the similarity in the frequency of orientation of strikes of steep and low dipping joints within the Buffalo Granite. It is assumed that the stress directions which formed the steep dipping joints (> 45°) is the same for those which formed the low dipping joints (< 45°).

low-dipping granite joints were products of the same stresses which produced the near vertical joints in the granite. It might also be speculated that the Buffalo granite was intruding partly simultaneously with the Beechworth pluton.

The concentric swing from 45° to 60° in the concentric modes noted in Fig. 4 is reflected in the primary modal spread of Fig. 11. The radial secondary mode of 135° is much more definite, as the sampling pattern over the granite localities probably favoured it. Had the aerial sampling of joints been more extensive in the east and southeast, perhaps the radial mode of 135° would have been represented also in the 150° sector. The sampling concentrated on the Mount Buffalo Road with some sampling on walking tracks on each side of the road, but this was minimal as time did not permit wider sampling.

Discussion

Principal joint sets in the Upper Ordovician sediments. The primary joint set in the seven samples of Upper Ordovician sediments in the NE of the area, from the contact outwards, is dominantly 45°–60°. These are transverse or dip joints in the Ordovician sedimentary rocks. The secondary joint set is in the WNW-ENE (120°) sector, subparallel with the strike of the Ordovician strata and are regarded as *strike joints*. The two sets of joints in the Ordovician host rocks reflect the regional stress field after these rocks had been folded.

Alignment of xenoliths in the Buffalo granite. Theory and practice suggests that xenoliths should be random, aligned parallel to the margins of the pluton, or aligned subparallel to a foliation if the granite body is deformed. The alignment of xenoliths in the Buffalo granite, where observed, conforms most closely to the dip and strike joints in the Ordovician sedimentary strata, but with a strong NNW-SSE mode as well. Buckingham and Joshi (1978) also recorded this mode in the Beechworth granite. They associated it with the Benambran (Lower Silurian) Orogeny.

Intrusive dykes and veins. The intrusive dykes and veins of aplite, felsite and quartz show a principal mode in the 30°–210° sector and a secondary mode in the 120°–300° sector. The most frequent dykes of aplite trend in the NE direction as do the xenoliths and the transverse joint sets in the Upper Ordovician strata.

Jointing in the granite. The jointing in the Buffalo granite consists of two joint sets of about equal strength, perhaps the primary set NE-SW, the secondary set NW-SE. This orthogonal pattern has a symmetry related to the stress field. This pattern reflects the residual stress within the granite on cooling. The jointing in the granite shows a swing of 15° when compared with that in the Upper Ordovician rocks, the xenoliths and thickest dykes. Maybe there was a refraction of stress across the granite-sedimentary rock

interface, or alternatively the stress pattern rotated through time. If Buckingham and Joshi (1978) regard the NW-SE mode seen in the xenolith rosette as Benambran, and the NE mode in the granite as Bowning Orogeny, the NW-SE joint mode in the granite could be a third deformation event, dominant in the Tabberabberan structural zone.

Steeply dipping and low dipping joints in the granite. The same principal joint modal directions are obtained for low dipping as for steep dipping joints. There was no difference in the stress pattern causing either joint type. It is interesting to note that a N-S mode (the tertiary mode) occurs in the steeply dipping joint rosette, possibly because the sample was larger and hence more comprehensive.

Acknowledgements

This structural survey would not have been completed without motivation from John Julian who worked on behalf of the FNCV in conjunction with Parks Victoria in the planned research activities 5-13 February, 1998, in celebration of the 100 years that Mount Buffalo National Park has been in existence. Help is gratefully acknowledged for work in the field by Richard Edwards (Benalla), Meredith Hartley (Shepparton), Rose Hegarty (Carrum), Glenda Datsun (Albury), Ian Endersby and Dorothy Mahler (FNCV). Richard and Meredith assisted with field measurements with the compass clinometer. All searched for xenoliths and intrusives. Ian Endersby supplied data on lower Rollason's Falls and Drill Hole Rocks tracks and contributed much to the interpretation of results. Thanks to their efforts the maximum coverage of the area in the time available was possible. The manuscript was greatly improved by positive helpful comments from an anonymous referee. A special thanks to Dorothy Mahler who typed the manuscript.

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FNCV Buffalo Mountains Excursion, January 1940
Geology of Mount Buffalo

The outstanding geological characteristic of Mount Buffalo is... the enormous amount of denudation that has taken place since the intrusion and solidification of this granite mass in the sedimentary rocks of this part of Victoria... Some indication of the amount of this denudation, largely due to stream erosion, can be gained by the study of a much earlier river system, remnants of which occur in the vicinity of the present divide some 25 miles to the south-east...Fossil plant remains found in these old river deposits indicate a Middle Tertiary age. The Buffalo granite possibly formed part of the core of this earlier divide, and we thus have evidence of great changes, particularly the removal of many thousands of feet of hard rock...

The disintegration of the Buffalo granite was greatly accelerated by the very pronounced jointing of the rocks, aided by the many destructive geological agencies, among them being the disruptive effects of alterations of heat and cold causing expansion and contraction in the rock...of water containing weak acids that exert a chemical action on the more susceptible components of the granite. These are the silicates of soda and potash of the felspars and micas..accounting for much of the disintegration along joint planes and the rounding of the angular blocks...

S.R. Mitchell, *The Victorian Naturalist* **41**, 1940, 183-184.

Mount Buffalo: Botanical Bridge or Island?

Neville Walsh[1]

Abstract

A consideration of plant species that are entirely or largely confined to Mount Buffalo suggests local speciation may have occurred since its isolation from other Victorian mountains. (*The Victorian Naturalist* **115** (5), 1998, 186-187).

Since the first botanical investigation of Mount Buffalo by Ferdinand von Mueller in 1853, the mountain and its surrounds have been a continuing source of interest for naturalists, amateur and professional. My own association with the mountain has been as both. As a youngster I enjoyed the mountain for its surprising Lake Catani (Pl. 7E), impressive exposed granite tors and secretive grassy clearings within Snow Gum *Eucalyptus pauciflora* and Alpine Ash *Eucalyptus delegatensis* forests, and of course, some monumental snowball battles. Later I was to investigate the plateau more intensively as part of a project to map treeless vegetation in alpine tracts of Victoria, and to identify sites of particular botanical significance in the high country. Following the wildfires that devastated much of the plateau in January 1984 (the effects of which will be evident for many decades to come), some of the plots used as key points in the mapping project became valuable reference points in monitoring the recovery of the treeless communities. This project is ongoing, but results to date indicate an extraordinary capacity of plant communities that have evolved on Mount Buffalo in a virtual absence of wildfire to reinstate themselves in a relatively short period.

The Victorian alps form a more or less continuous chain of peaks and plateaus from the Baw Baws to the north-east, where at the source of the Murray River near the Cobberas Mountains, they abut the Snowy Mountains of New South Wales. The Buffalo Plateau is the most isolated part of this system, with broad and deep valleys separating it from the nearest peaks (e.g. Mount Cobbler, Mount Feathertop).

The alpine and subalpine vegetation of the Victorian high country is overall rather uniform with a familiar sequence of mixed species forests, through Alpine Ash tall forests to Snow Gum woodlands, eventually giving way to heaths, grasslands and bog community complexes. Minor local variations on the theme occur due to geology, aspect, rainfall and the unfathomable random events that dictate plant distribution. At the highest altitudes in the State, the Bogong High Plains, Mount Feathertop and the Cobberas Mountains harbour a number of species that are to be shared only with the Snowy Mountains of New South Wales (e.g. Snowwort *Abrotanella nivigena*, Snow Willowherb *Epilobium tasmanicum*, Carraway *Oreomyrrhis brevipes*, Cushion Carraway *O. pulvinifica*, Plantain *Plantago glacialis*, Felted Buttercup *Ranunculus muelleri*, Alpine Pennywort *Schizeilema fragoseum*).

Mount Buffalo, however, is significant for its richness of species to be found only on that massif, probably having more local endemics than all other Victorian mountains, as well as having many species of very restricted occurrence. The true endemics are Buffalo Sallee *Eucalyptus mitchelliana*, Buffalo Sallow-wattle *Acacia phlebophylla*, Fern-leaf Baeckea *Babbingtonia crenulata* (formerly *Baeckea crenatifolia*), Buffalo Everlasting *Leucochrysum albicans* subsp. *albicans* var. *buffaloensis* and probably Snow Pratia *Pratia gelida* (the type of this species was supposedly gathered by Mueller from near the summit of Mount Wellington in 1861, but despite repeated searches in this and nearby localities, the species appears to be now confined to drying mud around pools and streams in the vicinity of Crystal Brook and Tatra Inn on Mount Buffalo; it is conceivable that Mueller's labelling of the non-Buffalo specimen was in error). There are also those species whose appearance on Mount Buffalo differs from their more familiar forms in other Victorian uplands, e.g. Tussock Grass *Poa costiniana* (here with leaves distinctly bluish and often more spreading compared to the typical dark green, erect plant observed in all other Victorian localities), and a very distinctive, rusty-tomentose form of Tree Lomatia *Lomatia fraseri*. Future taxonomic investigation may well show these (and perhaps others yet unknown) to be added to the list

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of Buffalo endemics. These species could be said to exemplify the island nature of the plateau, and perhaps have evolved (or are evolving) more or less in isolation from the rest of Victoria's alps.

Other species for which the mountain is the major stronghold include the Snow Gentian *Chionogentias cunninghamii* subsp. *major*, Buffalo Small-flowered Grevillea *Grevillea alpivaga*, Button Teatree *Leptospermum micromyrtus*, Buffalo Mint-bush *Prostanthera monticola* (the common name is misleading as it is shared with the higher ranges in southern NSW, and the leaves are not aromatic) (Fig. 2). These, as well as the widespread alpine/subalpine species, might be regarded as those which bridge Buffalo and the remainder of the mainland Australian alps. These species probably represent the more persistent elements of a formerly wide-ranging flora that has retreated to the high country since the last ice-age some 12,000 years ago.

Interestingly, the mountains to which Buffalo seems to share the greatest botanical affinities are not necessarily those to which it is closest. Although two species, the Glacial Eyebright *Euphrasia crassiuscula* subsp. *crassiuscula*, and at slightly lower altitudes Catkin Wattle *Acacia dallachiana*, provide a botanical link to Mount Feathertop and the Bogong High Plains, a more striking similarity is struck with the Baw Baw Plateau. On both mountains, the treeless vegetation is comprised largely of wettish grasslands and *Sphagnum* moss-dominated bogs. In both cases these communities are confined to the drainage lines, the peculiarly right-angular branching of which are a consequence of the intrinsic faulting and weathering patterns of the Devonian granite (Buffalo) or granodiorite (Baw Baw) that make up the plateaus. Both share similar altitude (c. 1400–1600 m) and rainfall (c. 1400–2100 mm p.a.). The discovery of Turquoise Coprosma *Coprosma moorei* in the course of mapping the vegetation on the mountain (at the time believed to be confined to the Baw Baws and Lake Mountain) seemed to confirm for me the botanical similarities of Buffalo and Baw Baw. *Coprosma moorei*, however, was soon to be found near Mount Howitt, and as recently as January this year, in an exquisite and extensive bog formation, near Mount Mackay on the Bogong High Plains (an area inexplicably excised from the Alpine National Park). Perhaps the Baw Baw Berry *Wittsteinia vacciniacea* will one day be discovered on Mount Buffalo – a relatively small extension of range from its disjunct occurrence on nearby Mount Cobbler.

So, to return to the title of this article, to what extent does the vegetation of Mount Buffalo indicate a phenomenon of local evolution, or merely reflect the scattered fragments of a formerly more extensive cool-climate flora? The concentration of highly localised species (subspecies, varieties) strongly suggest there has been a degree of evolution in isolation, probably during the last 12 000 years or so. Away from Mount Buffalo, the local subspecies of Snow Gum on the Baw Baws (subsp. *acerina*), Bogong High Plains (subsp. *hedraia*) and higher peaks in the alps generally (subsp. *niphophila*) (Rule 1994) are further testament to processes of local speciation following fragmentation of more wide-ranging distributions. A similar pattern is shown in the distribution of species and subspecies of *Euphrasia* in the high country (and Victoria generally) (Barker 1982). In the Victorian alps, the fragmentation has been both physical (by the creation of deep intervening valleys through erosion or faulting) and environmental (by the reduction, through climatic warming, of appropriate habitat to successively higher positions in the landscape).

Superimposed onto local evolution events are undoubtedly many episodes of local extinctions through fire, climate change, and since human occupation, land use (particularly cattle grazing and ski-field development), and random introductions from other areas through seed dispersal by wind and birds. We will never know exactly to what extent any of these processes have shaped the local floras of Victoria's (or Australia's) high country. Perhaps the imposition of an accelerated increase in temperature from global warming will allow us unhappily to observe one of these processes in action. Whatever, Mount Buffalo remains an excellent venue to ponder these possibilities and to enjoy a unique alpine environment. We are indeed fortunate that it has been preserved in a near-pristine state over this last century.

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Fourteen Plants and a Fungus: Ferdinand Mueller's Taxonomic Imprint on the Flora of the Buffalo Range

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Abstract

In February and March 1853 Mueller and Dallachy carried out the first botanical survey of the Buffalo range. Mueller used specimens they collected there to establish new taxa, including fourteen plants and a fungus. Consequently Mount Buffalo National Park is an important site of Australian botanical heritage. (*The Victorian Naturalist* **115** (5), 1998, 188-191).

Introduction

Gold was not the only enriching resource in Victoria in the 1850s. Less widely known is the Victorian flora's taxonomic lode which enriched the scientific botanical lexicon during that decade. While current maps carry names of places scratched on the Victorian landscape by gold diggers, the taxonomic system includes names assigned to many Australian plants by Dr Ferdinand Mueller before and after his appointment in January 1853 as Victoria's first government botanist. One of his early collecting destinations was the Buffalo range.

To Mount Buffalo in 1853

On 29th January 1853 Mueller left Melbourne on his first expedition as Government Botanist. Since the flora of the near-coastal lowlands of south eastern Australia had already been examined by various botanists, his primary objective was Victoria's undocumented alpine flora (Gillbank 1992). He would begin with Mount Buffalo, at The Horn (then known as Mount Aberdeen), and chose the well-trodden route to busy goldfields which Lieutenant-Governor La Trobe had named May Day Hills when inspecting them on 1st May 1852. In the sprawling canvas township, not yet named Beechworth, Henry Smythe was the resident gold commissioner and James Clow his first assistant. In January 1853 the prospecting population soared to about 8,000, and in that month the gold escort returned twice from Melbourne. The 185 mile route, via present day Benalla and Wangaratta, was 'literally crowded' (Woods 1985).

Accompanied by John Dallachy, the superintendent of Melbourne's botanic garden, and using horses and a cart, Mueller reached May Day Hills on 20th February 1853, and two days later wrote to the colonial secretary, William Lonsdale, of his intention to collect alpine plants on the Buffalo range to grow in the botanic garden. Perhaps Smythe and Clow knew enough of the ranges beyond the diggings to direct Mueller up the Ovens Valley to the Buffalo Plateau, or perhaps local cattlemen described the route forged one parched summer by drought-stressed cattle up the Buckland Valley and along what became known as Goldie's Spur to sub-alpine expanses of Snow Grass *Poa* spp. (Webb and Adams 1998). Perhaps Mueller knew of Edward Barnett's surveys of the Ovens and its tributaries, but a European silence probably shrouded any Aboriginal routes to summer feasts of Bogong Moths *Agrostis infusa* on the Buffalo Plateau.

Leaving Clow to forward his herbarium specimens to La Trobe, Mueller set off with Dallachy up the Ovens valley. Although they are not mentioned in his extant correspondence, Mueller would have passed through Hillas' Myrtle Creek run and Buckland's Porepunkah and Junction runs. Goldie managed Junction run which included the Buckland valley. Later (9/3/1853) Mueller informed Londsdale that on the range they met Barnett, who led them to the peak of Mount Aberdeen on February 25th, and claimed that this was 'the first ascent ever made of this mountain'. Certainly this was the first botanical survey of Mount Buffalo and its plateau.

Mueller and Dallachy travelled widely over the plateau, collecting living and herbarium specimens, but even on the two highest peaks found fewer 'new' plants than Mueller had hoped. Nevertheless, in

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the two weeks including his Buffalo foray, he reported (9/3/1853) adding nearly 50 species not previously recorded in Victoria. Some were potentially useful. Some, including a 'high Correa, and a Grevillea surpassing in size and splendour all others of this colony' were obviously beautiful. While mentioning 'many Quartz veins' Mueller made no mention of prospectors, cattle-men or cattle on the Buffalo Plateau.

In his annual report Mueller (1853) recorded that he had ascended

> 'Mount Aberdeen and another peak more than 4,000 feet high, and examined the rich, almost tropical, vegetation which borders the rivers rising in these mountains. It was in this locality that our exertions were rewarded with the discovery of the high majestic *Grevillea Victoriae*, and other rarities'.

In search of alpine plants, Mueller's European eyes saw 'almost tropical' vegetation on the plateau. His altitude measurements were underestimates. The Buffalo Plateau is over 4000 feet (c 1300 m) with many peaks over 1500 m. The two highest peaks are The Horn (1723 m) and The Hump (1695 m). Dates on Mueller's specimens in Melbourne's National Herbarium confirm that he spent twelve days collecting on the Buffalo Plateau, 25 February–8 March 1853. Unfortunately this is outside the flowering period of many Buffalo plants, making taxonomic determinations difficult. In his collecting site designation, *Buffalo Range*, Mueller included foothills as well as plateau and peaks, so that some of his collections, e.g. Long-leaved Box *Eucalyptus goniocalyx*, were from lower slopes outside the present boundary of the National Park.

It was well into autumn by the time Mueller and Dallachy descended to the Ovens valley. The lateness of the season and the condition of their horses made it impossible to extend their journey to higher mountains further east. Since 'Mount Aberdeen offered hardly any plants of a true Alpine character' Mueller (1853) resolved to ascend Mount Buller. Meanwhile Dallachy carted living specimens and seeds of the beautiful 'new' grevillea and correa and other attractive ornamental plants back to the botanic garden in Melbourne.

Mueller's botanical legacy on the Buffalo range

Mueller did not prepare a report devoted solely to his collections on the Buffalo range, but information included in his reports, taxonomic descriptions, herbarium specimen notes and correspondence reveals the taxonomic consequences of those collections. Most of the first annual report Mueller prepared as Government Botanist was devoted to his extensive 1853 expedition. In it Mueller (1853) mentioned useful and beautiful plants he had collected on Buffalo.

> 'Baeckea utilis, from Mount Aberdeen, might serve travellers in those desolate localities as tea, for the volatile oil of its leaves resembles greatly in taste and odour that of lemons not without a pleasant, peculiar aroma'.

Two of 'the most gorgeous plants' found during his expedition were 'the magnificent *Grevillea Victoriae*' and 'the grand *Correa Latrobeana*'.

To his early annual reports Mueller appended lists of the many hundreds of Victorian plants he had collected and examined during the previous twelve months. Many were his own taxonomic names - some for plants he first collected on Buffalo. In the species list appended to his first annual report, Mueller (1853) included Buffalo Sallow Wattle *Acacia phlebophylla*, Ovens Wattle *A. pravissima*, Mountain Baeckea *Baeckea utilis*, *Camphoromyrtus crenulata*, Mountain Correa *Correa latrobeana*, *Eucalyptus goniocalyx*,Royal Grevillea *Grevillea Victoriae*, Grey Mistletoe *Loranthus canus*, Elderberry Panax *Panax angustifolius*, *Phebalium asteriscophorum*, Grey Bush-pea *Spadostyles ternata* and Mountain Westringia *Westringia senifolia*. Later he listed *Brachychome ptychocarpa* (Mueller 1854) and Catkin Wattle *Acacia dallachiana* (Mueller 1858b) (Fig. 1). For these 14 taxa Mueller listed all but the last-mentioned *Acacia* before formally describing them. His annual systematics included no collecting information, but published descriptions of these 14 taxa (except the *Correa*) mention his Buffalo collections. Later collections from elsewhere are also sometimes noted. Mueller established half of these taxa in 1855 in the *Transactions* of two Victorian scientific societies. Other authors published several descriptions in 1856, and descriptions of the three species of *Acacia* were published later.

It is hardly surprising that the first Victorian subalpine botanical survey should yield plants new to science for

which Mueller could establish new taxa. Since nineteenth century taxonomic practice was much less rigidly controlled than is current practice, it is also not surprising that some of Mueller's mid-19th century names have not survived in current plant censuses. For reasons not detailed here, three Buffalo plants no longer carry names Mueller assigned to them over 140 years ago - *Loranthus canus*, *Panax angustifolius* and *Spadostyles ternata.* They were described by Mueller (1855d, 1855a) and Hannaford (1856). Today these plants are called *Amyema quandang*, *Polyscias sambucifolia* and *Pultenaea cunninghamii* respectively. The other eleven taxa are listed in Table 1. Their base names are the specific epithets Mueller assigned to them. They include two endemic species - *Acacia phlebophylla* and Fern-leaf Baeckea *Babingtonia crenulata.*

Eight of the eleven taxa in Table 1, including *Grevillea victoriae* which Mueller (1855b) erected from specimens of a 'truly majestic plant', remain as Mueller established them in the *Transactions* of Victoria's Philosophical Society and Institute for the Advancement of Science in 1855 and in his new *Fragmenta Phytographiae Australiae* in 1858, and as other authors published elsewhere in 1856 and 1931.

Fig. 1. Catkin Wattle *Acacia dallachiana.* F.v. M. fragmenta phytographiae Austaliae i. 7 (1858). From 'Iconography of Australian Species of Acacia and Cognate Genera'. 9th decade, by Baron Ferd. von Mueller (Government Printer: Melbourne 1888).
1, portion of a phyllodium; **2**, portion of a spike before expansion; **3**, portion of a spike, the flowers dropped; **4**, unexpanded flower; **6**, front-back view of a stamen; **7**, pollen grain; **8**, pistil; **9**; lower portion of a fruit-valve with a seed; **10**, a seed, separated; **11**, transverse section of a seed; **12** and **13**, longitudinal sections of seeds. All enlarged, but to various extent.

Mueller assigned specific epithets to three spring-flowering Buffalo wattles - *Acacia dallachiana* for Dallachy, *A. phlebophylla*, meaning veined leaves, and *A. pravissima* meaning very twisted, but to describe them he had to wait until he could examine their flowers. In his *Fragmenta Phytographiae Australiae* Mueller (1858a) described *A. pravissima* after he collected specimens elsewhere during a subsequent expedition, and *A. dallachiana* after plants were grown in the botanic garden (Mueller 1858b). *Acacia phlebophylla* was properly established much later. In the early 1860s Mueller described it in the first part of what he intended to be the second volume of his *Plants Indigenous to the Colony of Victoria,* but the volume was never published. Instead, when printing was discontinued after the fifth fascicle in 1863, Mueller sent a set of broadsheets to various European botanists, including Bentham at the Royal Botanic Gardens at Kew, England. Because the second volume was not effectively published, the new names included in the first five fascicles are invalid (Court *et al.* 1994). Consequently, *A. phlebophylla* was not established until it was described in H.B. Williamson's section on the Leguminosae in Alfred Ewart's *Flora of Victoria.*

Table 1. Current name, as listed in Ross (1996), Bean 1997 or Wilson (1998), of plant taxa established from specimens Mueller collected on Buffalo in 1853.

Acacia dallachiana F.Muell.
Acacia phlebophylla F.Muell.
Acacia pravissima F.Muell.
Asterolasia asteriscophora (F.Muell.)
Babingtonia crenulata (F.Muell.)
Baeckea utilis F. Muell.
Brachyscome ptychocarpa F. Muell.
Correa lawrenceana var. *latrobeana* (F.Muell. ex Hannaford) *
Eucalyptus goniocalyx F. Muell.
Grevillea victoriae F. Muell.
Westringia senifolia F. Muell.

* type specimen from the Delatite River.

Three of the taxa in Table 1 result from taxonomic revisions - Lemon Star Bush *Asterolasia asteriscophora*, *Babingtonia crenulata* and *Correa lawrenceana* var. *latrobeana*. Mueller (1855c) described *Phebalium asteriscophorum*, which was transfered in 1917 to the genus *Asterolasia*. Mueller (1855d) described *Camphoromyrtus crenulata* and later transferred it to the genus *Baeckea* (Mueller 1864); and on the recent reinstatement of the genus *Babingtonia*, it became *Babingtonia crenulata* (Bean 1997). Mueller wished to honor La Trobe by assigning his name to the grand correa he saw on the Buffalo Plateau. Samuel Hannaford (1856) included Mueller's '*Correa Latrobeana*' with a single-line description, but the plant had already been described by William Hooker as *Correa Lawrenciana*. Although Melbourne's National Herbarium contains several specimens which Mueller collected on the Buffalo range, Hannaford mentions only his collection on the Delatite River, which Mueller reached after leaving Buffalo. While working on *Correa* in preparation for its inclusion in the *Flora of Australia*, Paul Wilson (1998) corrected the spelling of Hooker's specific epithet (according to the International Code) and established *Correa lawrenceana* var. *latrobeana*. Now Buffalo's flora includes a grevillea honoring Queen Victoria and a correa honoring La Trobe, as Mueller had wished.

Mueller also collected mosses and at least one fungus on Buffalo. On The Horn on 5th March 1853 he collected a small red toadstool with a waxy cap. That specimen is the type of *Hygrophorus flammans*, part of which is in the National Herbarium, Melbourne, and part at Kew. It has not been re-collected and its status remains obscure.

In Summary

During Mueller's first expedition as Victoria's Government Botanist, he and Dallachy travelled beyond gold diggings and cattle stations to carry out the first botanical survey of the Buffalo range. On examining specimens collected there during nearly two weeks in the late summer and early autumn of 1853, Mueller described new taxa, including those of fourteen plants and a fungus. Specific epithets assigned by him are base names for the eleven taxa listed in Table 1. Mueller's establishment of taxa from specimens collected on the Buffalo range make it an important site of Australian botanical heritage.

Acknowledgements

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Mount Buffalo and Percival R.H. St. John

R.J. Fletcher[1]

Abstract

A review of some of the work of Percival R.H. St.John, with special reference to his efforts on Mount Buffalo during 1938 resulting in a collection presented to the Chalet by Russell Grimwade in February 1939. (*The Victorian Naturalist* **115** (5), 1998, 192-200).

Percy St. John, 11 May 1872 to 12 August 1944, the son of a Bourke St. taxidermist, became associated with the Botanic Gardens in Melbourne at the age of eleven. In the various records there are small differences concerning what he did at this tender age, but he was probably occupied, from July 1883, as a boy assistant to the seedsman. Some time later he was apprenticed to sign and label writing, tasks at which he excelled. During these early years he came under the benevolent notice of Baron von Mueller for whom he collected specimens and seeds, and was paid for his efforts (Morris 1944).

During the ensuing years he developed formidable skills in taxonomy while working successively as a storekeeper, seedsman, head gardener and classifier. His special area of interest, apart from a deep and abiding interest in ornithology (Walling 1944), was with the genus *Eucalyptus* (The Gum Tree 1930). He was an acknowledged expert in the identification of eucalyptus oils and developed this skill to the point where he could identify species from their oils. An example of this was his determination of a specimen of *Eucalyptus piperita* by the characteristics of its oil (Baker and Smith 1920).

Having commenced work in the Botanic Gardens in 1883, he retired from the National Herbarium in 1937, thus completing fifty-four years of service. During that time many of his own collections, especially of eucalypts, were added to the Economic Museum at the Botanic Gardens, and these were incorporated into the National Herbarium in 1935. His final two and a half years were spent in the new National Herbarium.

No doubt because of his special interest in the eucalyptus oils, he would have come under the notice of Russell (later Sir Russell) Grimwade, whose chemical company produced eucalyptus oils for pharmaceutical purposes, carrying on the pioneering work of Joseph Bosisto. St. John would have been well-known to Bosisto, who also worked in closely with Mueller. With all of these associations, and his well established expertise in taxonomy, it is hardly surprising that he was supported by Grimwade in making a survey of the flora of Mount Buffalo. Apart from being a successful businessman and well respected as a philanthropist, Russell Grimwade was also a keen field naturalist, being a member of The Field Naturalists Club of Victoria for many years.

Apart from these associations, St. John had an established reputation for making surveys in what were still relatively remote areas. Some of his excursions may be followed up by reference to earlier issues of *The Victorian Naturalist*, in particular Volumes XXV to XXVII between 1909 and 1911. In these volumes are recorded his efforts, along with those of A.J. Ewart and J.W. Audas, concerning the extensive work done on Wilsons Promontory, and also the exploration of the Brisbane Ranges and the Lerderderg River with J.G. O'Donoghue.

After Percival St. John had retired, he spent the spring of 1938 on Mount Buffalo collecting and identifying a selection of the plants growing there. The first stated aim of the St. John collection was that it would form a rough census of the natural vegetation on the plateau at the coming of the white man (Fig.1). Grimwade went on to say that if the collection survived it would show in the years to come any changes that took place by reason of the occupation of man of an area that had been without that influence for countless generations. This is in fact a point worth noting, for although the collection has been in safe keeping for sixty years, signs of deterioration are

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This collection of 125 specimens representing 37 Natural Orders is a wide, but not necessarily complete, survey of the flora of the Mount Buffalo Plateau.

It has been prepared for several reasons.

Firstly, to form a rough census of the natural vegetation occurring on the Plateau at the coming of the white man. If it survives it will show in the years to come any changes that take place by reason of the occupation by man of an area that has been without that influence for countless centuries.

Secondly, to provide a reference collection for the settlement of doubts that arise concerning the identity of plants growing on the Plateau, or of their occurrence thereon. Under the international agreements that govern the nomenclature of plants, changes from time to time are unavoidable. The specimens herein carry the names that are accepted as official and valid at the time of this collection.

Thirdly, to evoke or stimulate an interest in Victorian vegetation that may lead to its better protection. Much of this is rapidly becoming exterminated.

These Specimens have been collected, identified, mounted and labelled by P.R.H. St. John who ended in November 1937 a service of 54 years with the Botanical Gardens, Melbourne, and who has earned the respect and admiration of his fellow citizens by his energetic study, his knowledge and his exposition of the plants that have formed his environment through life. He alone is responsible for the identity of the specimens forming this collection.

As the author of the idea that there should be such a survey, I am grateful of the opportunity of using Mr. St.John's services in its making. His labours have been aided in great measure by the Commissioners of the Victorian Railways. I am honoured to give this collection to them to hold in trust for my fellow countrymen and their visitors.

February 1939

W. Russell Grimwade

Fig. 1. Transcript of a plaque at Mt. Buffalo Chalet.

evident which could perhaps be arrested by remounting on a more substantial base than the ageing paper. This wasn't original pioneering work, his mentor Baron von Mueller and the former Superintendent at the Botanic Gardens, John Dallachy, had already begun the work on the mountain in 1853, nearly twenty years before St.John was born. Their work is commemorated in many ways, including having their names incorporated in Yellow Kunzea *Kunzea muelleri*, and Catkin Wattle *Acacia dallachiana*.

Percival St. John was not commemorated in the same way, although in recognition of his work in this field the species Eurabbie, St. John's Blue Gum *Eucalyptus stjohnnii* (R.T. Baker) R.T. Baker was established. This recognition was lost when the species was reclassified as *Eucalyptus pseudoglobulus* Naudin ex Maiden (inc. *Euc. stjohnnii*), and is currently classified as Gippsland Blue Gum *Euc.globulus ssp. pseudoglobulus* (Naudin ex Maiden) J.B. Kirkp. 'Sic transit gloria'.

Since cattle were still being grazed on the Buffalo Plateau, a practice which continued up to 1958, it is hardly surprising to note that there are about 46 introduced species, including 13 grasses, among the approximately 460 species currently listed for the National Park (National Parks Service 1996). However, when St. John made his collection, he did not include any of these introduced species. The collection at the Chalet comprises 135 specimens, although the presentation plaque refers to 125. This discrepancy is accounted for by the fact that Russell Grimwade made the presentation in February 1939 and other items were added later.

For instance, the specimen numbered 58A, 'White Everlasting' *Helichrysum Baxteri (sic)* A. Cunn. (PL. 3A), was collected near the reservoir on 21 March 1939. This species still grows near the reservoir and was photographed on 21 March 1998 (PL. 3B). This specimen serves as one illustration of a point made by Grimwade at the presentation. He said that 'Under the international agreements that govern the nomenclature of plants, changes from time to time are unavoidable. The specimens herein carry the names which are accepted as official and valid at the time of this collection.' *Helichrysum baxteri* A.Cunn. ex DC. has become *Chrysocephalum baxteri* (A.Cunn. ex DC.) A. Anderb. There is a further complication in that *C. baxteri* does not appear on the plant list for Mount Buffalo National Park, and it would appear that the specimen is in fact Branched Everlasting *Helichrysum adenophorum* var.*waddelliae* J.H. Willis.

Even greater adventures in nomenclature have been enjoyed by St. John's specimen, number 13, of the Fishbone Water-fern

Blechnum discolor (Forst.) Keys var. *nuda* Domin. (Fig. 2). Instead of being included in the Order Polypodiaceae, this genus has for a long time been placed in the family Blechnaceae. Currently listed as *Blechnum nudum* (Labill.) Mett. ex Luerss., it has had incarnations under many names (Table 1). This serves to illustrate the difficulties facing field workers then and now.

Of the 135 specimens of the St. John collection housed at the Chalet, 80 have undergone name changes over the years. Of these, nine are merely the substitution of a lower case letter in the specific name, where it was the fashion of the time to use upper case when the name was that of a person, for example *Acacia Dallachiana* becomes *A. dallachiana*, but the other 71 are more substantial. A list comprising the current nomenclature has been prepared by the author and copies have been lodged with the management at the Chalet, the FNCV Library at Blackburn, and the National Herbarium at Melbourne (Appendix 1).

All four of the species endemic to Mount Buffalo: Buffalo Sallow Wattle *Acacia phlebophylla* (Fig. 3 and 3a); Fern-leaf Baeckea *Baeckea crenatifolia* (now *Babbingtonia crenulata);* Buffalo Sallee (Willow Gum) *Eucalyptus mitchelliana* (PL. 4A, 4B, 4C), and Buffalo Mint-bush *Prostanthera monticola (*PL. 2F) are represented in the collection. The latter is listed as Large-Flowered Mint-bush (Blotchy Mint-bush) *P. walteri.* Fern-leaf Baeckea is confined to rocky streamsides, and may be seen for instance along the Eurobin Creek/Eurobin Falls Track.

Fig. 2. Fishbone Water-fern *Blechnum nudum.*

Percival St. John noted that Buffalo Sallow Wattle *Acacia phlebophylla* was growing between granite boulders at Bent's Lookout, which is the area immediately below, and in front of, the Chalet. This species may well have been growing there in 1938, but not now. This may be due to the reason foreshadowed by Russell Grimwade, when he referred to the changes caused by man. Apart from the construction of the Lookout, which has involved the erection of a safety-fence and the use of quantities of concrete among the rocks, this is the major car-park for the area. However, it is not difficult to find this interesting plant, with its large leathery phyllodes and prominent veins, since it grows by the side of the road near Mackey's Lookout, and in profusion among the granite boulders near Reed's Lookout.

The third in this group, called variously by St. John 'Willow Gum'or 'Weeping Sally' and now named Buffalo Sallee *Eucalyptus mitchelliana,* is also easy to observe. Some branches overhang the footbridge between the Chalet and Lake Catani, and from this vantage point the close similarity of the buds to those of Black Sallee *E. stellulata* can be observed. The specimens growing in this area are tall and shapely, contrasting starkly with a specimen on the granite between Reed's Lookout and Manfield's Lookout. Here, at some time in the past, a large tree has fallen, and growing from the apparently dead base, survives a living branch, where once again the flowers, buds and fruit can be examined at eye-level.

Table 1. Some of the name changes for Fishbone Water-fern *Blechnum nudum.*

Onoclea nuda Labill.	1806
Lomaria nuda Willd	1810
Stegania nuda R.Br.	1810
Blechnum discolor (Forst.) Keys	1873
Lomaria discolor variety nuda Baker	1874
Blechnum nudum Mett.	1876
B. discolor sensu Ewart	1931
and currently:	
B. nudum (Labill.) Mett. ex Luerss.	1876

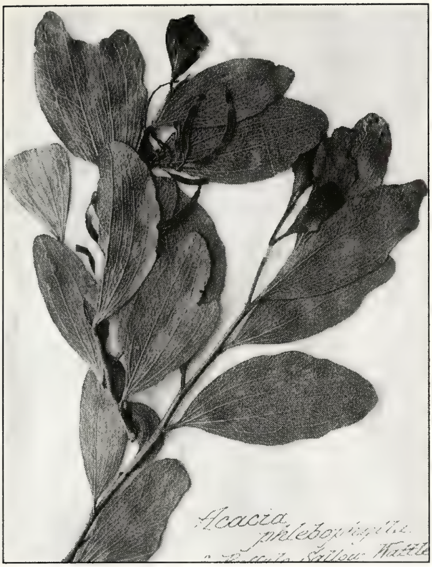

Fig. 3. St. John's specimen Buffalo Sallow Wattle *Acacia phlebophylla.*

Fig. 3a. Buffalo Sallow Wattle *Acacia phlebophylla,* in 1998.

Nearby, in the shadow of a huge boulder, is a much more majestic specimen, but with an easier life.

At this point there is a curious anomaly in St. John's collection. A specimen is labelled *Eucalyptus stellulata*, but the species is not currently found on the Buffalo Plateau. It is stated that it was common in the vicinity of the Chalet, although one supposes that at that altitude and in those conditions, it might more closely resemble the stunted version found at Brumby Point. It would seem unlikely that St. John would make an error of identification with a eucalypt, but because of the similarities with *E. mitchelliana* it is a possibility (see Lawler *et al.* 1997 for other explanations).

The fourth endemic, Buffalo Mint-bush *Prostanthera monticola* Conn, recently separated from *P. walteri,* may be found in several areas, including along the track from the Tatra Inn to Dickson's Falls.

Apart from the difficulty already mentioned with Black Sallee, there are a couple of other puzzles. One concerns the specimen labelled Hickory Tanning Wattle *Acacia falciformis*, and once again being noted as abundant near the Chalet. The specimen (Fig. 4) is clearly Hickory Wattle *Acacia obliquinervia.* Hickory Wattle is certainly abundant near the Chalet, for instance across the road at the approach to Bent's Lookout,

Fig. 4. Mountain Hickory Wattle *Acacia obliquinervia.*

and in fact on many other parts of the Plateau. There are many variations in the size and shape of the phyllode, and possibly St. John was not familiar with *A. falciformis.* The species is not found on Mount Buffalo at the present time, nor in the locality.

Table 2. Plants around Lake Catani listed by P.R.H. St. John in 1938 and found in 1998.

Spec. No.	Common Name	Botanical Name
23	Marigold, Marsh	*Caltha introloba*
29	Billy-buttons, Common	*Craspedia uniflora = C. glauca*
34	Pepper, Mountain	*Drymis lanceolata = Tasmannia lanceolata*
36	Heath, Swamp	*Epacris bawbawiensis = E. paludosa*
45	Gum, Snow	*Eucalyptus pauciflora*
50	Waxberry	*Gaultheria hispida = G. appressa*
50A	Gentian, Mountain	*Gentiana diemenica = Chionogentias cunninghamii*
58	Grevillea, Royal	*Grevillea victoriae*
63	Sunray, Hoary	*Helipterum albicans* = *Leucochrysum albicans* ssp. *albicans* var. *buffaloensis*
66	Hovea, Long-leaf	*Hovea longifolia = H. montana*
68	Isotome, Swamp	*Isotoma fluviatilis*
69	Kunzea, Yellow	*Kunzea muelleri*
74	Tea-tree, Mountain	*Leptospermum pubescens = L. grandifolium*
81A	Daisy, Yam	*Microseris scapigera = M.* aff. *lanceolata (Alps)*
86	Carraway, Australian	*Oreomyrrhis andicola = O. eriopoda*
98	Plum-pine, Mountain	*Podocarpus alpina = P. lawrencei*
101	Mint-bush, Alpine	*Prostanthera cuneata*
110	Buttercup, Alpine	*Ranunculus gunniana*
112	Heath, Candle	*Richea gunnii = R. continentis*
113A	Moss, Sphagnum	*Sphagnum cymbophyllum = Sphagnum* sp.
120	Panax, Elderberry	*Tieghemopanax sambucifolius = Polyscias sambucifolia*

The ongoing saga with the family Asteraceae is well illustrated among the collection. The specimen numbered 85 and labelled as Starry Daisy-bush *Olearia stellulata* is described elsewhere as a rare coastal shrub occurring at Mount Clay near Portland (Willis 1972). Mention has already been made of problems with the specimen labelled as White Everlasting *Helichrysum Baxteri.* Much less of a problem is the very well preserved specimen labelled Hoary Sunray *Helipterum albicans* (Pl. 3C, 3D). This has only involved a reallocation to *Leucochrysum albicans* ssp. *albicans* var. *buffaloensis*, and grows in profusion in the grassy areas around Lake Catani.

Most of the specimens are given a location in general terms, such 'around Lake Catani', 'near Wilkinson's Lookout' and so on, and in a limited time some of these were checked for the sake of current comparison, and were easily found. For example, around Lake Catani, in a habitat varying from sphagnum bog to grassland, were found those listed in Table 2. This is not, of course, a complete census of the area, and there are many specimens to be found that are not represented in St. John's collection. There are also items in the collection that are found around the lake, as well as in other sections of the Park, and are listed as having been collected in those areas. In this table, listed in the same numerical order as the collection, where there has been a change of name, the most recent is given second.

Two species specifically listed by St. John as occurring at the north end of Lake Catani are still to be found there. Growing in profusion along the margin of the walking track, towards the bridge and near the junction with the beginning of the View Point Nature Walk, is the Royal Grevillea *Grevillea victoriae*. An interesting feature on the occasion of the visit made for the purposes of this paper was that one shrub near the bridge was in full flower (Fig. 5 and 5a) and all other specimens seen were in fresh bud. The interest lies in the fact that this excursion was in late March, and Royal Grevillea is usually noted in the literature as flowering from November to February. The explanation for this apparently late flowering is no doubt connected with the fact that the season has been exceptionally dry. The bushes of Royal Grevillea growing densely along the edge of the track above The Crystal Brook near the Reservoir were also heavy in bud, promising an autumn show of flower.

Another specific item is Mountain Plum-pine *Podocarpus lawrencei* (Fig. 6, as *P. alpina*), placed by St. John as growing in the rocky gully at the north end of Lake Catani, where indeed it still does. One such plant, sprawled across a boulder just below

Fig. 5. St. John's specimen Royal Grevillia *Grevillea victoriae*.

Fig. 5a. Royal Grevillia *Grevillea victoriae,* 1998

Fig. 6. St. John's specimen of Mountain Plum-pine *Podocarpus lawrencei.*

the weir and consisting mainly of a gnarled grey trunk with a few green shoots, looks venerable enough to have been there sixty years ago. Nearby, also prostrate on the rock, is a much younger and healthier plant. But just a little further down Eurobin Creek, growing near the bank, there is a magnificent specimen which would appear to assure the survival of the species for many years to come.

St. John's specimen numbered 79, collected near Wilkinsons Lookout, and labelled Long-leaved Lomatia *Lomatia myricoides,* presents an interesting situation. A thorough search of the area revealed only one specimen of a Lomatia. The area consists of a stand of Alpine Ash *Eucalyptus delegatensis* with an understorey of Mountain Shaggy-pea *Podolobium alpestre* and some Elderberry Panax *Polyscias sambucifolia.*

There has been much revision within the family of Lomatia, with the added difficulty that several of the species are subject to hybridisation. The single specimen found near Wilkinsons Lookout, not far off the track towards Reeds Lookout, is growing at an altitude of about 1300 m. River Lomatia (Long-leaf Lomatia) *Lomatia myricoides* is said to grow below 1000 m and along waterways. (See reference to 'Flora of Australia' p. 377). Without detriment to St. John's efforts, it would appear, in the light of current knowledge, that his specimen is in fact Forest Lomatia *Lomatia fraseri.*

Two of the stated aims of the collection have already been mentioned. These were to form a rough census of the natural vegetation on the Plateau, and to provide a reference collection for the settlement of doubts concerning the identity of the plants, which at the time carried the accepted official names. A third aim was to evoke or stimulate interest in Victorian vegetation that would lead to its better protection. There can be no doubt that each of these aims has been realised. Although there have been many changes in nomenclature, the labelling in the enviable handwriting of P.R.H. St. John, another skill for which he was noted, is still there to be seen and to stimulate in others a proper appreciation of the treasures awaiting them in their explorations of the Buffalo Plateau.

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The assistance of Helen Cohn, Library Manager at the National Herbarium in Melbourne, for access to the biographical files, and of Neville Walsh, Botanist, also of the National Herbarium, for assistance with nomenclature, is very much appreciated. Andrea Rose of the Staff at the Mount Buffalo Chalet was most helpful in affording the opportunity to study and photograph the St. John collection. Peter Jacobs, Ranger in Charge at Mount Buffalo National Park, also offered valuable assistance and advice.

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Appendix 1

P.R.H. St. John Collection – Drawer No. 1

(Current name in brackets if different)

Listed Name	Common Name
1. Acacia alpina	Alpine Wattle
2. Acacia Dallachiana (*Acacia dallachiana*)	Catkin Wattle
3. Acacia falciformis $^{\alpha}$	Large-leaf Hickory Wattle
4. Acacia phlebophylla $^{\beta}$	Buffalo SallowWattle
5. Asperula Gunnii (*Asperula gunnii*)	Mountain Woodruff
5A. Asplenium flabellifolium	Necklace Fern
6. Asterolasia Muelleri (*Asterolasia asteriscophera*)	Lemon Star-bush
7. Asterotricha ledifolia (*Astrotricha ledifolia*)	Common Star-hair
8. Baeckea crenatifolia (*Babbingtonia crenulata*)	Fern-leaf Baeckea
9. Baeckea Gunniana (*Baeckea gunniana*)	Alpine Baeckea
10. Baeckea ramosissima	Rosy Baeckea
11. Billardiera longiflora	Purple Apple-berry
12. Billardiera scandens	Common Apple-berry
13. Blechnum discolor var. nuda (*Blechnum nudum*)	Fishbone Water-fern
14. Blechnum pennamarina	Alpine Water-fern
15. Bossiaea algida (*Bossiaea bracteosa*)	Mountain Leafless Bossiaea
16. Bossiaea foliosa	Leafy Bossiaea
17. Brachycome nivalis (*Brachyscome nivalis*)	Snow Daisy
18. Brachycome scapiformis (*Brachyscome spathulata*)	Spoon Daisy

P.R.H. St. John Collection – Drawer No. 1 cont.

Listed Name.	Common Name
19. Bredemeyera ericinum (*Comesperma ericinum*)	Heath Milkwort
20. Caladenia alpina (*Caladenia lyalli*)	Mountain Caladenia
21. Callistemon pallidus	Lemon Bottlebrush
22. Callistemon Sieberi (*Callistemon sieberi*)	Alpine Bottlebrush
23. Caltha introloba	Marsh Marigold
24. Calytrix scabra (C.virgata) (*Calytrix tetragona*)	Common Fringe-myrtle
25. Celmisia longifolia (*Celmisia* sp.)	Silver Daisy
26. Cheilanthes tenuifolia (*Cheilanthes austro-tenuifolia*)	Rock Fern
27. Claytonia australasica (*Neopaxia australasica*)	White Purslane
28. Coprosma hirtella	Rough Coprosma
29. Craspedia uniflora (*Craspedia glauca*)	Common Billy-buttons

α This specimen is *Acacia obliquinervia* Mountain Hickory Wattle. *A. falciformis* is not currently recorded for MountBuffalo.

β *Acacia phlebophylla* Buffalo Sallow Wattle can be seen at Mackey's Lookout or Reed's Lookout, but not in the vicinity of Bent's Lookout.

P.R.H. St. John Collection – Drawer No. 2

Listed Name.	Common Name
30. Daviesia ulicina var. ruscifolia (*Daviesia ulicifolia*)	Gorse Bitter-pea
31. Dianella revoluta	Black-anther Flax-lily
32. Dillwynia floribunda (*Dillwynia sericea*)	Showy Parrot-pea
33. Dodonea viscosa var spathulata (*Dodonea viscosa ssp. cuneata*)	Wedge-leaf Hop-bush
34. Drimys lanceolata (*Tasmannia lanceolata*)	Mountain Pepper
35. Drosera Planchonii (*Drosera macrantha*) χ	Climbing Sundew
36. Epacris bawbawiensis (*Epacris paludosa*)	Swamp Heath
37. Epacris breviflora	Drumstick Heath
38. Epacris microphylla (*Epacris gunnii*)	Coral Heath
39. Erigeron pappachroma (*Erigeron pappochroma*)	Violet Fleabane
40. Erythraea centaurium (**Centaurium pulchellum*)	*Austral Centaury
41. Eucalyptus Dalrympleana (*Eucalyptus dalrympleana*)	Mountain Gum
41A. Eucalyptus Dalrympleana (*Eucalyptus dalrympleana*)	Mottled Gum
42. Eucalyptus gigantea (*Eucalyptus delegatensis*)	Alpine Ash
43. Eucalyptus Mitchelliana δ (*Eucalyptus mitchelliana*)	Buffalo Sallee
44. Eucalyptus niphophila (*Eucalyptus pauciflora*)	Snow Gum
45. Eucalyptus pauciflora (E.coriacea) (*Eucalyptus pauciflora*)	Snow Gum
46. Eucalyptus stellulata ε	Black Sallee
47. Euphrasis collina	Purple Eyebright
48. Exocarpus cupressiformis	Cherry Ballart
49. Exocarpus stricta (*Exocarpus strictus*)	Pale-fruit Ballart
50. Gaultheria hispida (*Gaultheria appressa*)	Waxberry
50A. Gentiana diemenica (*Chionogentias cunninghamii*)	Mountain Gentian
51. Geranium sessiliflorum (*Geranium solanderi*)	Austral Cranesbill
52. Gleichenia dicarpa	Pouched Coral-fern
53. Gnaphalium alpigenum (*Euchiton umbricolus*)	Cliff Cudweed
54. Goodenia elongata	Lanky Goodenia
55. Goodenia hederacea var. alpestris	Ivy Goodenia
56. Grevillea australis	Alpine Grevillea
57. Grevillea parviflora (*Grevillea alpivaga/ G. linearifolia*)	Small-flowered Grevillea
58. Grevillea Victoriae (*Grevillea victoriae*)	Royal Grevillea

χ This specimen may be *Drosera peltata ssp. auriculata* Errienellam.

* Introduced species.

δ Endemic on Mount Buffalo

ε Not currently listed for Mount Buffalo. Possibly misidentification of *Eucalyptus mitchelliana*.

P.R.H. St. John Collection – Drawer No. 3

Listed Name.	Common Name
58A. Helichrysum Baxteri ϕ (*Chrysocephalum baxteri*)	White Everlasting
59. Helichrysum lepidophyllum (*Ozothamnus hookeri*)	Scaly Everlasting
60 Helichrysum rosmarinifolium (*Ozothamnus rosmarinifolius*)	Rosemary Everlasting
61. Helichrysum semipapposum (*Chrysocephalum semipapposum*)	Clustered Everlasting
62. Helichrysum Stirlingii (*Ozothamnus stirlingii*)	Ovens Everlastung
63. Helipterum albicans (*Leucochrysum albicans ssp. albicans* var. *buffaloensis*)	Hoary Sunray
64. Hibbertia linearis (*Hibbertia obtusifolia*)	Showy Guinea-flower
65. Hibbertia serpyllifolia	Guinea-flower
65A. Histiopteris incisa	Bat's-wing Fern
66. Hovea longifolia (alpine form) (*Hovea montana*)	Long-leaf Hovea
66A. Hymenanthera angustifolia (*Hymenanthera dentata*)	Tree Violet
67. Isotoma axillaris	Rock Isotome
68. Isotoma fluviatilis	Swamp Isotome
69. Kunzea Muelleri (*Kunzea ericifolia*)	Yellow Kunzea
70. Kunzea parviflora	Violet Kunzea
71. Kunzea peduncularis (*Kunzea ericoides*)	Burgan

P.R.H. St. John Collection – Drawer No. 3 cont.

Listed Name.	Common Name
72. Lagenophora Billardieri (*Lagenifera stipitata*)	Blue Bottle-daisy
73. Leptospermum myrtifolium	Myrtle Tea-tree
74. Leptospermum pubescens (*Leptospermum grandifolium*)	Mountain Tea-tree
75. Leucopogon Hookeri (*L. suaveolens*)	Mountain Beardheath
76. Lilaeopsis australica [γ] (*Lilaeopsis polyantha*) [γ]	Australian Lilaeopsis
77. Lomatia Fraseri (*Lomatia fraseri*)	Tree Lomatia
78. Lomatia ilicifolia	Holly-leaf Lomatia
79. L. myricoides	River Lomatia
80. Marianthus procumbens (*Rhytidosporum procumbens*)	White Marianth
81. Micrantheum hexandrum	Box Micrantheum
81A. Microseris scapigera (*Microseris aff. lanceolata*)	Yam Daisy (Alps)
81B. Notelaea ligustrina	Privet Mock-olive
82. Olearia erubescens	Moth Daisy-bush

Listed Name.	Common Name
83. Olearia gunnii (*Olearia phlogopappa*)	Dusty Daisy-bush
84. Olearia lirata	Snowy Daisy-bush
85. Olearia stellulata [η]	Starry Daisy-bush
86. Oreomyrrhis andicola (*Oreomyrrhis eriopoda*)	Australian Carraway
87. Orites lancifolia	Alpine Orites
88. Oxylobium alpestre (*Podolobium alpestre*)	Mountain Shaggy-pea
89. Oxylobium ellipticum [ι]	Golden Shaggy-pea

ϕ *Chrysocephalum baxteri* is not listed for Mount Buffalo. This specimen is likely to be *Helichrysum adenophorum* var. *waddelliae* Waddell Everlasting J.H. Willis 1945.

γ Not currently on plant list for Mount Buffalo.

η Not currently on plant list for Mount Buffalo. Limited in distribution to Mount Clay, near Portland? See 'A Handbook to Plants in Victoria' (1972) Vol. 2 J.H. Willis.

ι Not currently on plant list for Mount Buffalo.

P.R.H. St. John Collection – Drawer No. 4

Listed Name.	Common Name
90. Pelargonium australe	Austral Storksbill
91. Persoonia chamaepeuce	Dwarf Geebung
92. Phebalium podocarpoides (*P. squamulosum ssp. alpinum*)	Alpine Phebalium
93. Pimelea alpina	Alpine Rice-flower
94. Pimelea involucra (*Pimelea linifolia*)	Slender Rice-flower
95. Pimelea ligustrina	Tall Rice-flower
96. Plantago tasmanica (*Plantago alpestris*)	Tasman Plantain
97. Platylobium formosum	Handsome Flat-pea
98. Podocarpus alpina (*Podocarpus lawrencei*)	Mountain Plum-pine
99. Polystichum aculeatum var. proliferum (*Polystichum proliferum*)	Mother Shield-fern
100. Poranthera microphylla	Small Poranthera
101. Prostanthera cuneata	Alpine Mint-bush
102. Prostanthera hirtula	Hairy Mint-bush
103. Prostanthera lasianthos	Victorian Christmas-bush
104. Prostanthera rotundifolia	Round-leaf Mint-bush
105. Prostanthera Walteri (*Prostanthera monticola*)	Buffalo Mint-bush
106. Pteridium aquilinum var. esculentum (*Pteridium esculentum*)	Austral Bracken
107. Pteridium aquilinum var. lanuginosum (*Pteridium esculentum*)	Austral Bracken
108. Pultenaea Hibbertioides (*Pultenaea mollis*)	Soft Bush-pea
109. Pultenaea tenella	Delicate Bush-pea
110. Ranunculus Gunnianus (*Ranunculus gunnianus*)	Gunn's Alpine Buttercup
111. Ranunculus hirtus (*Ranunculus plebeius*)	Forest Buttercup

Listed Name.	Common Name
112. Richea Gunnii (*Richea continentis*)	Candle Heath
112A. Senecio lautus (*Senecio pinnatifolius*)	Variable Groundsel
113. Scleranthus biflorus	Twin-flower Knawel
113A. Sphagnum cymbophyllum (*Sphagnum sp.*)	Sphagnum Moss (Bog Moss)
114. Stackhousia monogyna	Creamy Stackhousia
115. Stellaria pungens	Prickly Starwort
116. Stylidium graminifolium	Grass Trigger-plant
117. Stypandra caespitosa (*Thelionema caespitosum*)	Tufted Blue-lily
118. Tetratheca thymifolia	Pink-bells
119. Thysanotus tuberosus	Common Fringe-lily
120. Tieghemopanax sambucifolius (*Polyscias sambucifolia*)	Elderberry Panax
121. Trachymene lanceolata (T. Billardieri) (*Platysace lanceolata*)	Shrubby Platysace
122. Viola Betonicifolia (*Viola betonicifolia*)	Purple Violet (Showy Violet)
123. Veronica Derwentia (*Derwentia derwentiana*)	Derwent Speedwell
124. Veronica nivea (*Derwentia nivea*)	Milfoil Speedwell
124A. Wahlenbergia vincaeflora (*Wahlenbergia stricta*)	Tall Bluebell
125. Westringia senifolia	Alpine Westringia

Note: Current nomenclature is given according to 'A Census of the Vascular Plants of Victoria' J.H. Ross, 5th. Edition, 1996, and 'Flora of Victora' Vol. 2 (1994) and Vol. 3 (1996), Edited by N.G. Walsh and T.J. Entwisle.

Buffalo Sallee at the Back Wall: An Alpine Species Adapted to Fire and Drought

Susan Lawler[1], Sarah Brown[1], Geoffrey Edney[1],
Sharon Howlett[1] and Pettina Love[1]

Abstract
Our survey of the Back Wall population of Buffalo Sallee *Eucalyptus mitchelliana*, showed that most of the individuals had survived the 1985 fire in this area, and may have survived other fires as well, since many of the living trunks were over 50 years old. While individuals of Snow Gum *Eucalyptus pauciflora* had twice as many trunks as Buffalo Sallee, they were on average only half as old, suggesting that the Buffalo Sallee are better able to survive fire. Buffalo Sallee were also found in shallower soils than Snow Gum, often in exposed situations, indicating that they are also better adapted to drought. (*The Victorian Naturalist* **115** (5), 1998, 201-205)

Introduction

Buffalo Sallee *Eucalyptus mitchelliana* is a willow-leaved Snow Gum endemic to Mount Buffalo, where it occurs on three steep granite faces (The Gorge, Mount McCleod, and The Back Wall). In each location it mixes in varying degrees with the Snow Gum *Eucalyptus pauciflora*. Two of these sites were examined in a previous paper, and compared to a granite outcrop (Mount Dunn) where *E. mitchelliana* does not occur (Lawler *et al.* 1997). No environmental differences were found to explain the absence of Buffalo Sallee at Mount Dunn. However, the fire history of the sites differed: Mount McCleod had a serious fire in 1972 and The Gorge area was burned extensively in 1939. Mount Dunn not only escaped these fires, but also the fire of 1985 which burned the third population of *E. mitchelliana* at The Back Wall. Mount Dunn's central location on the plateau may protect it from fires that invade the plateau from the valley, and the absence of fire at Mount Dunn in known history supports this view. Perhaps fire is a requirement for establishment or persistence of this endemic, and Mount Dunn does not experience enough disturbance to maintain *E. mitchelliana* populations.

The Back Wall may provide the best opportunity to examine the impact of fire and competition on *E. mitchelliana*. On the high southern edge of the plateau where conditions are cold and dry, this is the largest population, by far, of *E. mitchelliana,* covering at least 50 acres (P. Massingham *pers. comm.*). Burnt extensively in 1985, the evidence of fire can be clearly seen, particularly in the coppiced growth form, in which a large number of dead stags mix with new branches grown from the base of the tree. This multi-branched form is rare elsewhere, particularly among specimens near The Gorge with which most people are familiar. Also, unlike Mount McCleod and The Gorge, where Mountain Gum *E. dalrympleana* and Alpine Ash *E. delegatensis* also occur, at The Back Wall *E. mitchelliana* has only one Eucalypt competitor, the Snow Gum *E. pauciflora.*

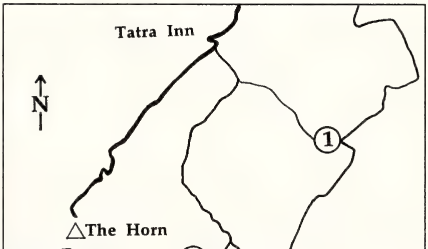

Fig. 1. The location of the four study sites in relation to The Horn. The walking track begins near Tatra Inn. Site 1 = Dickson's Falls, Site 2 = Western Loop, Site 3 = Back Wall, and Site 4 = Eastern Loop. The outline of the figure corresponds to the 1300 m contour on the Mount Buffalo Plateau.

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Methods

We chose four sites near The Horn (Fig. 1): one at Dickson's Falls, where there is no Buffalo Sallee (Fig.2); two along the eastern and western loops of the trail; and one at the Back Wall, where Buffalo Sallee predominates on the granite outcrops (Fig. 3). A total of a hundred individuals were surveyed, comprising a total of 386 live and 232 dead standing trunks. Table 1 describes the sites and the number of each species surveyed. The Eastern Loop site, which was just past a bridge on the way to The Back Wall, did not appear to have been burnt recently. Its position in a steep gully may have protected it from fire. Unlike the other sites, it contains many large, single stemmed specimens of *E. mitchelliana*. At the Back Wall, where the plateau drops steeply to the south, the accompanying species comprising the undergrowth changed. Monkey Mint-bush *Prostanthera monticola* and Leafy Bossiaea *Bossiaea foliosa*, which were common at other sites, were not seen, and Mountain Needlewood *Hakea lissosperma* occurred only at The Back Wall. Due to the distances involved, visiting each site and surveying 25 trees took a whole day.

Fig. 2. Sharon Howlett, Geoff Edney, Pettina Love and Sarah Brown taking measurements on *E. pauciflora* at Site 1 (Dickson's Falls).

Fig. 3. Pettina Love and Sharon Howlett below an *Eucalyptus mitchelliana* at The Back Wall.

Twenty five trees were chosen at each site. At sites 1 and 3 our transects closely followed the track, which naturally followed a gradient of soil depth and altitude approaching the Falls or the Wall. At site 2, where *E. pauciflora* occurred on one side of the track and *E. mitchelliana* on the other, our transect ran across the track to include both species. At site 4, our sample consisted of a selection of trees on a protected slope northwest of the track.

We counted and measured all live and dead trunks at breast height, estimated the height and measured soil depth at the base of each tree. Soil samples were taken from several locations at each site and analysed using the Innoculo Soil pH Test Kit (CSIRO).

We also cut a 2 cm slice from a fallen dead branch of each species, which allowed us to count the number of tree rings and determine a growth rate for trees at several sites (Fig. 4). The rate was determined by taking the shortest and longest distance from the perimeter to the center, and averaging the increment for every 5 rings. This information has been used to estimate the age of the standing trunks.

Results

Eucalyptus mitchelliana was found growing in shallower soil than *E. pauciflora*, and this result was significant ($p<0.01$, Pearson correlation) even when we did not include the site where *E. mitchelliana* did not grow (see Fig. 5). That is, in mixed

Table 1. The number of individual Buffalo Sallee *Eucalyptus mitchelliana* (M) and Snow Gum *E. pauciflora* (P) surveyed, and the altitude, aspect and fire history of each site

Site	Location	M	P	Altitude	Aspect	Fire History
1	Dickson's Falls		25	1440 m	SE	Burned 1985
2	Western Loop	10	15	1500 m	E	Burned 1985
3	Back Wall	9	16	1370 m	S	Burned 1985
4	Eastern Loop	5	20	1480 m	SE	Not burned in 1985

populations, *E. mitchelliana* is always found growing in the most granitic, exposed locations with the shallowest soil.

The pH of soils in this study varied only slightly (4.5 and 5.5). Nevertheless, *E. mitchelliana* were found growing in lower pH soils, on average, than *E. pauciflora* (4.7 vs. 5.0). This is consistent with previous results where mean soil pH values were 4.8 and 5.0 for the same two species (Lawler *et al.* 1997).

The growth rates, as estimated by counting tree rings from a slice of dead trunk, are presented in Table 2. Site 1 is not included because no dead wood was cut there. The *E. pauciflora* rate at Site 2 was used to estimate the age of trees at Site 1. Interestingly, trees of both species at Site 4 had a much faster growth rate. This site had several very large specimens (Fig. 6). Growth rates were used to estimate the age of the largest living trunk on each tree for each site.

About 22% of the trees had a largest living trunk of 15 years old or less, and this did not differ between species. Thus it appears that at least 3/4 of the current population survived the 1985 fire.

The age distribution of the sites differed (data not shown). Dickson's Falls and the protected Eastern Loop site both had several trees with estimated ages of over 150 years (see Fig 6). The Back Wall and the Western Loop, which were more exposed, did not have any individuals older than 120 years. Although our sample size was small, we made an effort to include the largest and smallest trees we could find, so these observations may point to a decreased ability to survive fire at exposed granite sites.

The standing trunks for *E. pauciflora* had about twice as many trunks per plant, on average, as *E. mitchelliana*, and this was true for both living and dead trunks (Table 3). While *E. pauciflora* had many more trunks, *E. mitchelliana* were much older, with the average age of the largest living trunk more than twice that of *E. pauciflora*. Only two living trunks of *E. pauciflora* were more than 50 years old, compared with 25 trunks of *E. mitchelliana* which were more than 50 years old, with half of those over 100 years old. All *E. mitchelliana* over 120 years old were found at Site 4.

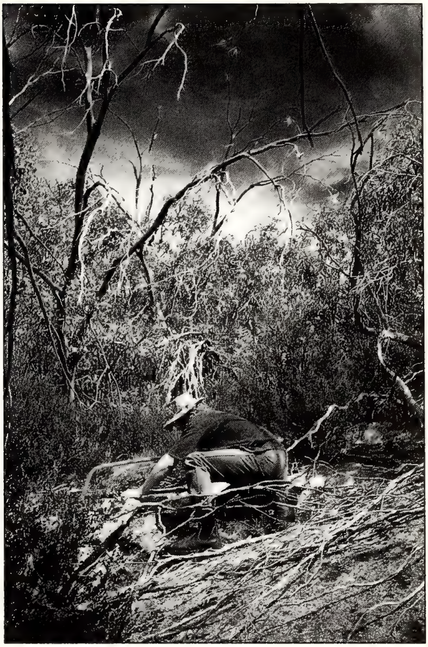

Fig. 4. Taking a 2 cm slice of dead wood for growth ring analysis.

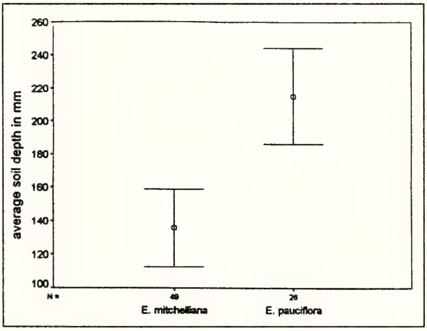

Fig. 5. Comparison of soil depths measured for the two species at Sites 2–4 where these species co-existed. The error bars show the 95% confidence intervals.

Table 2. Growth rates in mm radius, as estimated by averaging tree ring accumulation rates from a sample of dead wood at each site. *(E. mitch* = Buffalo Sallee *Eucalyptus mitchelliana; E. pauc.* = Snow Gum *E. pauciflora)*

Site		*E. mitch.*	*E. pauc.*
2	Western Loop	1.6625	1.6875
3	Back Wall	1.983	1.5215
4	Eastern Loop	2.4855	2.5715

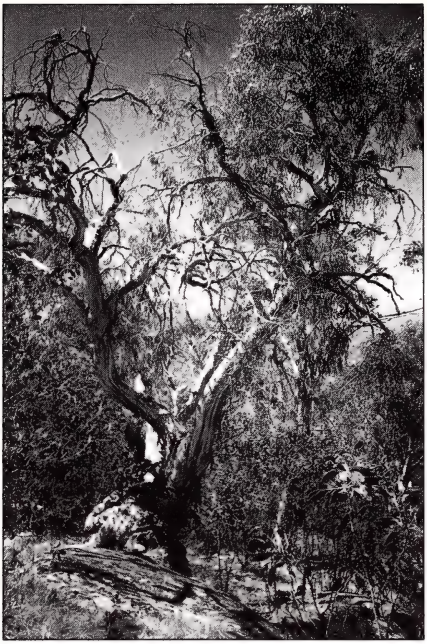

Fig. 6. Old *Eucalyptus mitchelliana* at Site 4.

Table 3. The average number and estimated age of standing trunks per plant for each species. *(E. m* = Buffalo Sallee *Eucalyptus mitchelliana; E. p* = Snow Gum *E. pauciflora)*

	E. m.	***E. p***
Average number of live trunks	2.92	4.69
Average number of dead trunks	1.59	3.00
Average age in years of largest live trunk	67.87	33.18
Average age in years of largest dead trunk	30.93	34.90

Discussion

Ashton *et al.* (1983) found that Snow Gums at Lake Mountain recovered rapidly from the 1939 fire; as dense canopy of multi-stemmed trees in 1962, thinning to well-spaced single stemmed trees by 1982. Although we did not quantify the canopy cover in this study, we found areas of multi-stemmed *E. pauciflora* so thick we could barely move at Site 2, while the most open canopy occurred at Site 4, which was not affected by the 1985 fire. Clearly, regeneration after fire is a common pattern among both types of Snow Gums, with multi-stemmed forms common for decades following a fire event.

Eucalyptus pauciflora and *E. mitchelliana* regenerated differently at the Back Wall as shown by the fact that *E. mitchelliana* had far fewer and much older standing trunks. This suggests a differing strategy after fire; while *E. pauciflora* produces many new shoots after fire, *E. mitchelliana* stems are more resistant to fire, reducing the need to reshoot.

In both species, most living trees survived the 1985 fire. Seedlings of both species were found at all sites during this study, and 22% of the current population are younger than 15 years. Nevertheless, the multi-stemmed forms of the trees, combined with the many large fallen trunks scattered throughout the area, indicate a very old population that has been regenerating from lignotubers, possibly after fire, for many hundreds of years. Both of these species can clearly tolerate a significant amount of fire disturbance, but *E. mitchelliana* stems seem better able to survive a fire event. Ironically, the purest stands of *E. mitchelliana* are found at exposed sites where few of the individuals were older than 100 years. It could be that growth at these sites is slowed by the dry conditions, and our growth rates (which are based on one sample/site) may not accurately reflect this.

Competition between the two Snow Gums cannot be demonstrated with our data, but the restriction of *E. mitchelliana* to the harshest and most exposed cliff faces on the plateau seems to indicate that *E. pauciflora* outcompetes it elsewhere. The significant difference between soil depth for each species, even with our relatively small samples, shows that *E. mitchelliana* grows in more marginal habitat even when the populations are mixed. In resource-poor situations, such as the Victorian alps, stress tolerance can be an important component of competitive ability (Theodose and Bowman 1997).

Over recent geological history, the Mount Buffalo Plateau has had wide variations in climate. Twenty thousand years ago, the temperature would have been 10 degrees cooler (Barlow 1986), and the entire plateau would have been covered with snow-adapted species. The current distribution of both Snow Gums must represent a restriction of their formerly widespread alpine habitat.

In conclusion, we have collected evidence that fire does not have a negative impact on either species of Snow Gum at the Back Wall, since both of these populations have been there for a long time. On the other hand, increasing fire frequency within the National Park is not likely to improve the prospects of the endemic Buffalo Sallee, since the populations that have not been burnt recently (Site 4 Lake Catani) are known to produce seedlings. More likely, Buffalo Sallee is found at those sites where rocky outcrops provide the high altitudes, shallow soil and high fire frequency to which they are adapted, and that the Mount Buffalo plateau is one of the few remaining places where these factors are combined.

Acknowledgements

Many thanks to the rangers at Mount Buffalo who provided access and a bush saw, and to Julie Makings who helped on the last day when we needed it. Also many thanks to the hardy Victorian Naturalists who walked to the Back Wall loop with SL during the Centennial Expedition. This research was undertaken under National Park (Victoria) permit 978/155.

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Buffalo Sallow Wattle *Acacia phlebophylla* of Mount Buffalo

Dean Heinze[1], Geoff O'Neill[1], Emma Briggs[1] and Tracey Cardwell[1]

Abstract

On the granite outcrops of Mount Buffalo the rare *Acacia phlebophylla* appears to be declining. At Rollason's Falls and Mackey's Lookout we collected data on the form and health of *A. phlebophylla* individuals, and the characteristics of habitat. The species appears to have specific habitat requirements and is prone to gall attack and both drought and gall infestations seem to have a detrimental impact on the population. (*The Victorian Naturalist* **115** (5), 1998, 205-209).

Introduction

The Buffalo Sallow Wattle *Acacia phlebophylla* is one of three rare plant species endemic to Mount Buffalo. Other species are the Buffalo Sallee *Eucalyptus mitchelliana* and the Fern-leaf Baeckea *Baeckea crenatifolia* (=*Babbingtonia crenulata*). To date there has been limited study of *A. phlebophylla.*

In general, *A. phlebophylla* is found on the north eastern slopes of the Mount Buffalo massif, on well-drained and exposed granite outcrops (600–1400 m above sea level). Much of the population is located within Special Protection Zones at Mackey's Lookout and Rollason's Falls (Parks Victoria 1997), but is also known from around The Gorge (Reed's Lookout), Mount McLeod, and the lower reaches of Buffalo Creek and Eurobin Creek. The population of *A. phlebophylla* is estimated (via visual estimates) to be approximately 3000 individuals (A. Marion *pers. comm.*), and its conservation status is considered 'rare', at both State and National levels (Parks Victoria 1997).

Acacia phlebophylla is most commonly found growing in rocky crevices near water courses with species such as the Myrtle Tea-tree *Leptospermum myrtifolium*, Violet Kunzea *Kunzea parvifolia*, Lemon Bottlebrush *Callistemon pallidus*, Common Fringe-myrtle *Calytrix tetragona* and scattered small stands of Brittle Gum

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Eucalyptus mannifera (DCE 1992; Costermans 1992). These heath communities are considered to be at an advanced stage in the colonisation of granite outcrops (Rowe 1970).

The most distinctive features of *A. phlebophylla* are its large phyllodes (4–14 cm long, 1.5–6 cm wide) and the large numbers of woody galls located on its branches. These galls are abnormal developments or outgrowths of the plant tissue resulting from irritation caused by agents including bacteria, fungi or insects (Williams 1994), but in the case of *A. phlebophylla*, the primary gall causing agent is a rust fungus *Uromycladium* sp. (Burges 1934). Galls on *A. phlebophylla* take many shapes, sizes and colors, appearing as warts, swellings or as knots on leaves, twigs and branches and are most common in areas of active growth. New (1997) notes that many gall insects are plant specific, and each gall has a very characteristic form. Insects commonly inhabit old rust galls and their activities may prematurely kill the gall (Burges 1934), restricting the plant's food supply at that point. This can result in the death of branches distal from the gall.

The Mount Buffalo National Park Proposed Management Plan (DCE 1992) identified the possible threats to this wattle species as road making, drainage and reclamation work, as well as its susceptibility to gall-rust disease. *Acacia phlebophylla* requires occasional natural disturbances for the opportunity to spread and establish itself. Regeneration is dependent on fire, flooding events, or an unusual combination of seasonal conditions (DNRE 1996; Parks Victoria 1997).

There is some concern over the health of the *A. phlebophylla* population on Mount Buffalo, as individuals are dying, presumably because after the rocky water-courses dry out, the resulting stress makes it easy for the Acacia to be overwhelmed by galls. In this study, we set out to compare briefly the characteristics of habitat, and the effects of galls on *A. phlebophylla*.

Study Sites

Two study sites were selected: Mackey's Lookout and Rollason's Falls (Fig. 1). Both these areas are located within Special Protection Zones (Parks Victoria 1997).

Mackey's Lookout consists of large exposed granite outcrops occupied by dry heathland (Fig. 2). At this site *A. phlebophylla* is found growing alongside the *Calytrix tetragona*, *Kunzea parvifolia*, Wedge-leaf Hop-bush *Dodonaea cuneata*, *Callistemon pallidus*, *Leptospermum myrtifolium*, Tree Lomatia *Lomatia fraseri* and *Eucalyptus mannifera*. Fire last affected this area in 1939.

By comparison, the outcrop at Rollason's Falls consists primarily of metamorphosed sedimentary rock. Here *A. phlebophylla* is concentrated on the edges of the Buffalo Creek, often growing amongst Burgan *Kunzea ericoides*, but also with Mountain Hickory Wattle *Acacia obliquinervia*, Narrow-leafed Peppermint *Eucalyptus radiata*, Mountain Swamp Gum *Eucalyptus camphora*, Broad-leaved Peppermint *Eucalyptus dives*, Cherry Ballart *Exocarpos cupressiformis*, Wedge-leaf Hop-bush *Dodonaea cuneata* and *Lomatia fraseri*. Rollason's Falls was last affected by fire in 1972.

Methods

At each site, 2x100 m transects were placed through *A. phlebophylla* habitat (at Rollason's Falls both transects bisected the creek). For each site, a random quadrat (20×20 m) was also constructed and *A. phlebophylla* individuals were measured in the same way as those found along each transect.

Height, width and girth (circumference at 200, 400 and 600 mm from the base of the plant) measurements were recorded for each *A. phlebophylla* encountered along the transect. In addition, percentage estimates were made of the number of branches occupied by galls, as well as the percentage of dead branches on each tree. Soil depths (three measures) were also recorded from around the base of each tree.

Results and Discussion

Results of measurements are presented in Table 1.

Tree form and health

Our results indicate that there are considerable differences between *A. phlebophylla* individuals at Rollason's Falls and Mackey's Lookout. But in general, most of the individuals studied were found to be growing in shallow soils.

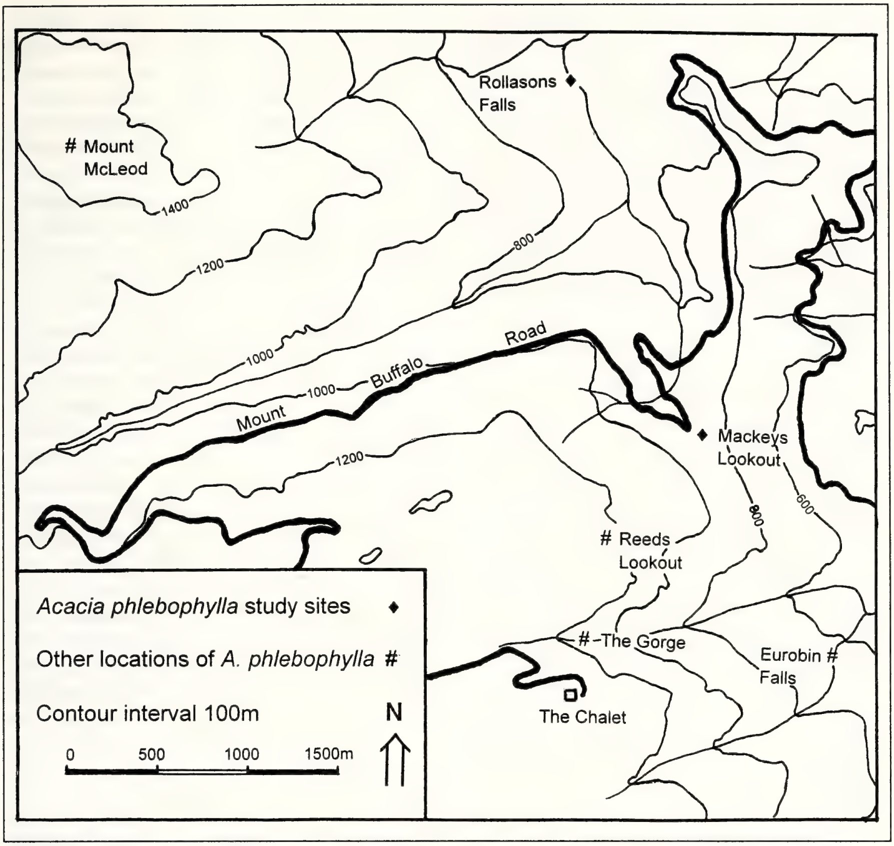

Fig. 1. The location of Buffalo Sallow Wattle *Acacia phlebophylla* study sites on Mount Buffalo.

Table 1. Measurements of Buffalo Sallow Wattle *Acacia phlebophylla* at Rollason's Falls and Mackey's Lookout. **Key**: n= total no trees measured; N_1= no of living trees; N_2= no of dead trees; p= t test.

	Rollason's (n = 63)	**Mackey's** (n = 45)
Rock type	Metamorphic sedimentary	Granite
Tree		
height (mean)	3480.0 mm	2663.0 mm
width of canopy spread(mean)	1207.0 mm	1615.0 mm
circumference of girth (mean)	140.0 mm	202.0 mm
Soil depth < 50 mm (mean)	67.2 mm	63.0 mm
% of individuals with soil depth above 150 mm	20%	42%
% of living branches on living trees (p<0.001)	N_1 = 48 Mean 75% SD 27	N_1 = 29 Mean 41% SD 38
% galls on living trees (p<0.001)	N_1 = 48 Mean 40% SD 31	N_1 = 29 Mean 82% SD 27
% galls on dead trees (p<0.001)	N_2 = 15 Mean 54% SD 36	N_2 = 16 Mean 99% SD 2
Trees with galls present	87%	100%
Dead Trees	24%	36%

Fig. 2. Buffalo Sallow Wattle *Acacia phlebophylla* occurs in the dry heathland on the granite outcrops of Mackey's Lookout, Mount Buffalo.

Acacia phlebophylla plants at Rollason's Falls tend to be tall and spindly (means: 3480 mm tall, 1207 mm wide, 140 mm girth) and are commonly growing amongst thickets of *K. ericoides*. Those that had a bushy form were found growing closest to the creek's edge in the open rocky outcrops. Of the 48 living individuals recorded, only five trees were located on the shaded, southern aspects (north side of Buffalo Creek), suggesting that *A. phlebophylla* is intolerant of shade.

At Mackey's Lookout, *A. phlebophylla* has a bushy form (means: 2663 mm tall, 1615 mm wide, 202 mm girth) which seems to relate to the openness of the heathland habitat, and reduced competition with other species for light.

Galls

At both Mackey's Lookout and Rollason's Falls we found a high degree of gall infestation on *A. phlebophylla*, which affected all age classes. Mature trees may have hundreds of galls affecting all branches, but seedlings with fewer than a dozen phyllodes have also been observed with gall attacks. The initial sites of gall infection are commonly at the reproductive organs, phyllodes and young branches (Fig. 3). The galls then turn bulbous. As Burns (1995) noted, most galls form when the invading organism causes hormonal changes in the plant which stimulate rapid, abnormal plant growth. These abnormal growths divert food away from normal tissues, weakening the plant and the fast rate of growth may also crush normal tissues, cutting off sap flow or otherwise interfering with plant function. It is likely that the gall growths on *A. phlebophylla* restrict the plant's food suppy, eventually killing the branches they occupy, thus affecting the health of individuals. Heavy gall infestations can cause premature decline of the plant (D. Heinze *pers. obs.*).

Our results demonstrate that galls, dead branches, and deaths of *A. phlebophylla* were significantly more prevalent (t test $p<0.001$) on individuals occurring at Mackey's Lookout than on those at Rollason's Falls (see Table 1). At Mackey's Lookout all individuals had galls, 82% of the total branches on these individuals had galls growing on them, and only 41% of the branches were still alive. At Rollason's Falls 87% of the individuals had galls, 40% of the total branches had galls growing on them and 75% of the total branches were still alive. Although individuals at Mackey's Lookout are more susceptible to gall attack, it is unclear whether the high mortality and declining health of these individuals can be attributed to this factor.

The causing agent of the galls on *A. phlebophylla* appears to be species specific and no other tree species in the study sites were observed with the *A. phlebophylla* gall type. It is likely that the causing agent of the galls is a rust fungus with insects as secondary invaders.

Conclusion

From our observations, *A. phlebophylla* is an obligate rocky outcrop dweller, a species that is capable of persisting on rocky outcrops with high light intensity, rock fractures or little soil, and regular seepage. Coates and Kirkpatrick (1992) state that obligates may be restricted to these environments by the properties which, although equipping them for survival in

Fig. 3. Galls develop along the inflorescence and also affect the phyllodes and young branches of Buffalo Sallow Wattle *Acacia phlebophylla*.

environmental extremes, also deny them access to more widespread habitats. They may be a species which is excluded from other more hospitable environments by competition. *Acacia phlebophylla* may flourish and have its range extended after fire, but is restricted by drought. Eventually the competition for water and light from other vegetation may force it to retreat to an open, rocky outcrop habitat.

If there is no fire or disturbance at Rollason's Falls it is likely that numbers of *A. phlebophylla* within the Burgan thickets will decline due to the ongoing competition, since recruitment is almost impossible due to shady conditions caused by the Burgan thicket. *Acacia phlebophylla* will then be restricted to the open, rocky areas of the creek line, on the north eastern aspects.

At Mackey's Lookout, numbers may decline due to the deaths related to old age, gall influence and desiccation during long dry periods (such as drought). Without fire, numbers are likely to persist on the exposed granite outcrops, but not in other areas where competition for light may be a limiting factor. It is likely that other factors such as drought may cause deaths. For example, there is evidence that patches of vegetation on the exposed granite outcrops have been drying out and dying during the dry summers of 1997 and 1998. Thus, it appears that these summers may have caused the death of trees throughout the north-east of Victoria (D. Heinze *pers. obs.*). Dry conditions over the last few years, when the seepage water dried up, appear to have had a detrimental effect on *A. phlebophylla* at Mackey's Lookout – we observed individuals that had recently died or had browning foliage due to water stress (Fig. 4).

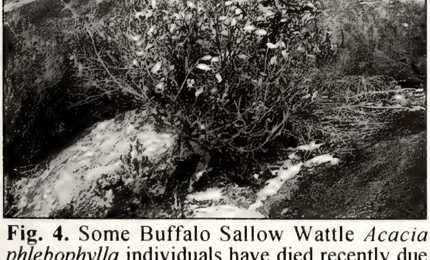

Fig. 4. Some Buffalo Sallow Wattle *Acacia phlebophylla* individuals have died recently due to dry conditions.

Therefore, it appears that the species distribution is largely determined by the availability of water, so that where the species is found along the open aspects of creeks, the individuals appear to be healthy. Most of the population is found along the joint planes and soaks of the north-facing granite outcrops, both of which may completely dry out in extreme summers.

Acacia phlebophylla is susceptible to gall attacks, which affect most of the population. From our brief study it is hard to quantify the degree of decline caused by the effects of galls on *A. phlebophylla*, as other factors such as competition and drought are also influential

Acknowledgments

Thanks to the Mount Buffalo National Park Rangers, especially Allison Marion, who provided us with information about *A. phlebophylla*. Susan Lawler and Alex Olejniczak corrected drafts of the manuscript. Thanks to Gretna Weste for her suggestions. This research was undertaken under National Park (Victoria) permit NP978/158.

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Lichens of Mount Buffalo National Park: A Preliminary Report

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Abstract
Lichens were collected from Mount Buffalo National Park in the summer of 1998. A preliminary list of 35 lichens is given and two new records for Victoria are reported, *Canoparmelia corrugativa* (Kurok. & Filson) Elix & Hale and *Xanthoparmelia rupestris* Elix & J.Johnst. (*The Victorian Naturalist* **115** (5), 1998, 210-214).

Introduction

Lichenology is comparatively little studied in Australia, when one considers the vast array of information available for vascular plants. At Mount Buffalo National Park the recorded vascular plants number 476 (Walsh 1982), and approximately 88 species of fungus are known (May 1997). Few lichens, however, have been recorded from Mount Buffalo to date.

In 1904, The Field Naturalists Club of Victoria Mount Buffalo Camp-out recorded a total of five lichen species: '*Parmelia perforata* Wulf.; *Cladonia pyxidata*; *Cladonia aggregata* Ach.; *Parmelia* (*conspersa*?), *Usnea barbata* L., var. *dasypogo*'(Coghill 1904). This appears to be the only information published on the area regarding lichens, and the taxonomy is now somewhat out of date. *Cladonia aggregata* is now *Cladia aggregata* and *Parmelia conspersa*, if this species was identified correctly, is now *Xanthoparmelia conspersa* (Ach.) Hale which is not known for Australia (Filson 1996). Similarly, *P. perforata* was also incorrectly reported from Australia (Filson 1996). The species *U. barbata* var. *dasypogo* never appears to have been formally recognised. Australian records of *U. barbata* are actually *U. scabrida* (Filson 1996). *Cladonia pyxidata* is the only name still in current use, and this species was not identified during the course of this study.

The lack of information on lichen distribution is primarily due to difficulties associated with lichen taxonomy. However, as continuing taxonomic work leads to a greater understanding of lichens, these difficulties are beginning to diminish.

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Method

Lichens were collected within the National Park 'Mueller' style, that is by walking along a number of tracks around the plateau and down the north to north-east face of the mountain, and collecting any lichens seen. Lichens were also collected from areas off the tracks. Survey areas included: The Horn, Buffalo Lodge area, the Back Wall, Dickson's Falls, Old Galleries, Lake Catani, Monolith Track, Hospice Plain, Reservoir, Wild Dog Plain, The Chalet area, Mackay's Lookout, Rollason's Falls, Eurobin Falls and the beginning of the Big Walk along Eurobin Creek at the base of the mountain (Fig. 1). The northwestern part of the Park was not included in the survey, and there were a number of walks that also were not included. The absence of these areas from the survey is primarily due to time and travel limitations. Collecting was minimised to avoid destruction of lichen assemblages so species common throughout the study region were collected from several, but not all regions. Thus the report provides a list of lichen species for Mount Buffalo generally, not a list of species for each particular area surveyed. Nomenclature follows that of the *Flora of Australia*, Volumes 54 and 55.

Lichens were collected from a variety of substrata including bark, soil, granite rock and sedimentary rock (at Rollason's Falls). The survey of granite rock is incomplete due to the difficulties of removing lichens from this substratum type.

Results

A total of 35 species were identified from the Mount Buffalo Plateau and the lower reaches of the National Park (Table 1). The family Parmeliaceae was the best represented with a total of five genera and 14 species identified. The most common

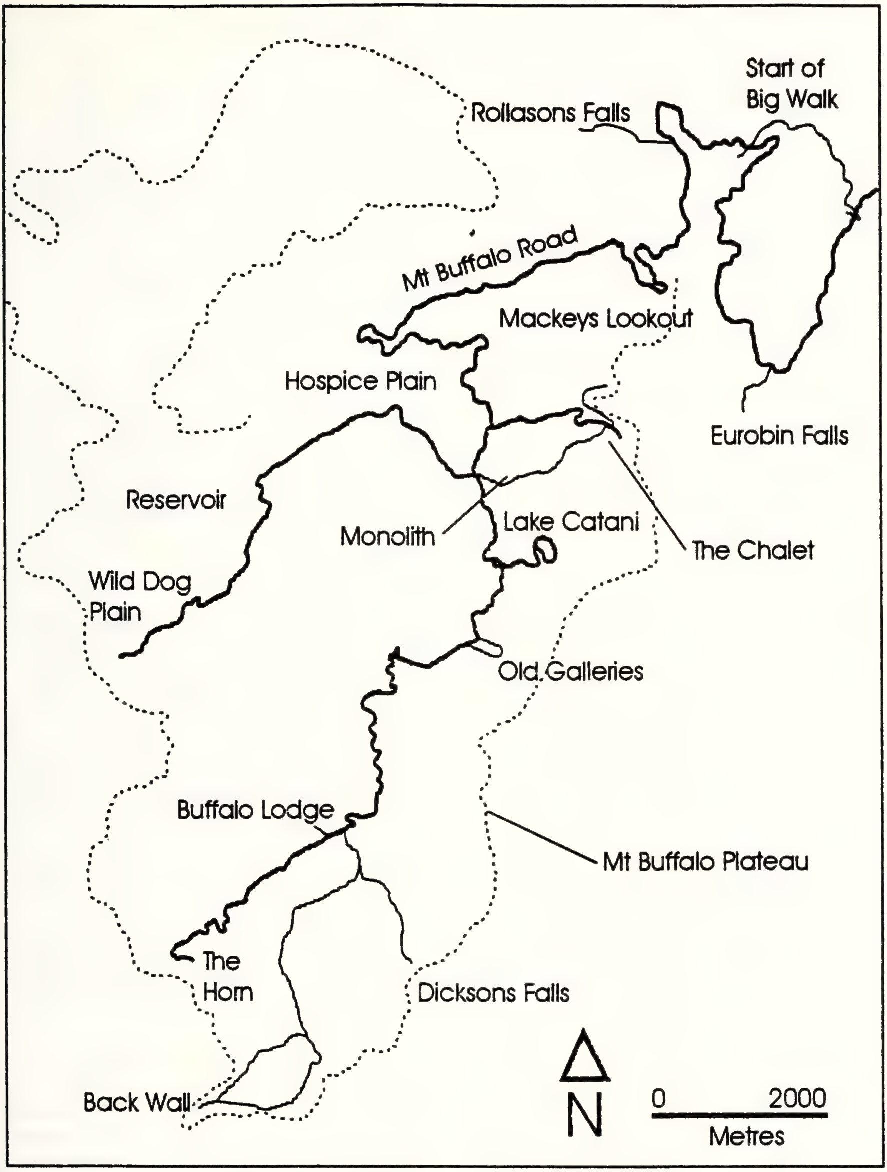

Fig. 1. Location of collection areas, Mount Buffalo National Park (adapted from 'Parks Victoria, Centenary Chronicle').

genera were *Parmelia* and *Xanthoparmelia*. Hypogymniaceae was also well represented with two genera that are of this family, *Hypogymnia* and *Menegazzia*, occurring with a total of four and two species respectively. The Cladoniaceae and Cladiaceae are each represented by one genus, *Cladonia* and *Cladia*, with four and two species respectively.

Two new records for Victoria were recorded: *Canoparmelia corrugativa* (Kurok. & Filson) Elix & Hale and *Xanthoparmelia rupestris* Elix & J. Johnst. *Canoparmelia corrugativa* (Pl. 5C) was

Table 1. A preliminary list of the lichens of the Mount Buffalo National Park.
N=New record for Victoria; E=Endemic; R=rare species.

Baeomyces heteromorphus Nyl.
[N]*Canoparmelia corrugativa* (Kurok. & Filson) Elix & Hale
Cladia aggregata (Sw.) Nyl.
Cladia schizopora (Nyl.) Nyl.
Cladonia capitellata (Hook f. & Taylor) C.Bab
Cladonia floerkeana (Fr.) Florke
Cladonia pleurota (Florke) Schaer
[E]*Cladonia staufferi* Abbayes
Flavoparmelia haysomii (C.W. Dodge) Hale
Hypogymnia lugubris var. *sublugubris* (Müll.Arg.) Elix
Hypogymnia mundata (Nyl.) Oxner ex Rass.
Hypogymnia pulverata (Nyl.) Elix
Hypogymnia subphysodes var. *subphysodes* (Kremp.) Filson
Menegazzia aeneofusca (Müll.Arg.) R. Sant.
Menegazzia platytrema (Müll.Arg.) R. Sant.
Neophyllis melacarpa (F. Wilson) F. Wilson
Pannoparmelia wilsonii (Rasanen) D.J. Galloway
Parmelia cunninghamii Cromb.
Parmelia pseudotenuirima Gyeln
Parmelia signifera Nyl.
Parmelia tenuirima Hook f. & Taylor
Parmotrema chinense (Osbeck) Hale & Ahti
Pseudocyphellaria neglecta (Müll.Arg.) H. Magn.
Psoroma fruticulosum P. James & Hessen
Rhizocarpon geographicum (L.) DC.
Stereocaulon corticatulum Nyl.
Teloschistes sp. Norman
Umbilicaria cylindrica (L.) Delise
Usnea sp. Dill. ex Adans.
Xanthoparmelia cordillerana (Gyeln.) Hale
Xanthoparmelia dichotoma (Müll.Arg.) Hale
Xanthoparmelia luminosa (Elix) Hale
[N]*Xanthoparmelia rupestris* Elix & J.Johnst.
[R]*Xanthoparmelia suberadicata* (Abbayes) Hale
Xanthoparmelia substrigosa (Hale) Hale

found on *Acacia obliquinervia* Tindale in close proximity to the Chalet but it was only found on one tree in the area, and not recorded elsewhere in the park. This species, previously known from New South Wales and South Australia, is a rare, endemic species that grows on bark (Elix 1994a). *Xanthoparmelia rupestris* (Pl. 5D) also was recorded near the Chalet, on rock. This species is, so far, known from New South Wales, Australian Capital Territory and Western Australia where it is rare on subalpine rock (Elix 1994b).

Other notable finds included the rare *Xanthoparmelia suberadicata* (Abbayes) Hale (Pl. 5E), at Hospice Plain and near Buffalo Lodge and the endemic *Cladonia staufferi* Abbayes (Pl. 5F) which was found on soil around the Reservoir in an open aspect position. *Cladonia staufferi* is unique among Australian species of *Cladonia* in that it is confined to areas of regular snowfall (Archer 1992).

There are approximately 40 lichens still requiring identification, and this is especially the case for the crustose* varieties which are difficult to identify as few current keys exist. However, as more species are identified from the Mount Buffalo National Park the updated list will be offered to *The Victorian Naturalist*.

* See glossary at end of paper

A number of lichen assemblages were identified in the Mount Buffalo National Park. These occurred in different habitats. There were also a number of species common throughout the Park.

Exposed rock faces generally supported crustose lichens such as the very common, but beautiful *Rhizocarpon geographicum* (L.) DC., a bright lime-green and black lichen common throughout the Park. Some hardy foliose* lichens also were found in exposed situations such as *Xanthoparmelia luminosa* (Elix) Hale (Pl. 5G), which was found only at Hospice Plain and Wild Dog Plain and was observed to 'cap' large boulders, somewhat like a coating of icing, or snow.

Rock crevices and sheltered rock surfaces supported an assemblage of *Parmelia signifera* Nyl., *Psoroma fruticulosum* P.James & Hessen, *Hypogymnia lugubris* var. *sublugubris* (Müll.Arg.) Elix and *Menegazzia aeneofusca* (Müll.Arg.) R. Sant. *Menegazzia aeneofusca*, a closely appressed, foliose form, had much larger, more lush thalli in sheltered situations than when it occurred in more open regions. Very large specimens of *Umbilicaria cylindrica* (L.) Delise (Pl. 5H) were observed on the protected eastern face of The Horn. Although observed frequently on rock surfaces throughout the park,

U. cylindrica did not occur in such high cover, nor as such large specimens (up to 6 cm long), in any other part of the Park. This grey, foliose species is characterised by black, brain-like fruiting structures (apothecia), and, in smaller specimens, many black hairs (cilia) surrounding the lobes of the lichen. It is attached from a single point, a holdfast or umbilicus.

On flattened surfaces under rock overhangs, species such as *Flavoparmelia haysomii* (C.W. Dodge) Hale, *Menegazzia aeneofusca*, *Stereocaulon corticatulum* Nyl., *Teloschistes* sp., *Cladia aggregata* (Sw.) Nyl., *Parmelia signifera* and species of *Cladonia* were found, often as a carpet-like mat of lichen.

***Eucalyptus pauciflora* Sieb. ex Spreng. bark** supported comparatively few lichens. This was thought to be because the bark of *E. pauciflora* is shed periodically, and lichens require a stable surface on which to grow. Species of *Usnea* were common on the decorticate, dead branches of the snowgums, while the thick, persistent bark around the bases of *E. pauciflora* provided a suitable substratum type for *Hypogymnia* and *Menegazzia* species.

***Eucalyptus delegatensis* R.T. Bak./ *Eucalyptus radiata* Sieb. ex. DC. wet sclerophyll forests** around Rollason's Falls and Eurobin Falls, supported a very different community to the parts of the Park at a higher altitude. Interesting species recorded only in these lower altitude areas of the Park included *Pseudocyphellaria neglecta* (Müll.Arg.) H. Magn. and *Xanthoparmelia dichotoma* (Müll.Arg.) Hale on moist sedimentary rocks, *Neophyllis melacarpa* (F. Wilson) F. Wilson and *Pannoparmelia wilsonii* (Rasanen) D.J. Galloway occurred on the fibrous bark of eucalypts. The latter species is small with finger-like projections (isidia) on its surface and an underside reminiscent of the pads of a cat's paw. All of the *Parmelia* species, *P. cunninghamii* Cromb., *P. pseudotenuirima* Gyeln., *P. tenuirima* Hook. f. & Taylor and *P. signifera*, occurred in the Rollason's Falls area. Apart from *P. signifera*, which grows on rock, these species were corticolous* and often found around the bases of the eucalypts.

Common species such as *C. aggregata*, *C. schizopora*, *P. signifera*, *S. corticatulum*, *R. geographicum* and *M. aeneofusca* appear to have a wider ecological tolerance as they were recorded both in the lower altitude areas of the park as well as on the Plateau. *Rhizocarpon geographicum* and *M. aeneofusca* were found on sedimentary sandstone in the Rollason's Falls area, and on igneous granite rock tors on the plateau. They appear to show little saxicolous* substrate preferences.

Other host species in these forests included *Acacia obliquinervia* Tindale, *Acacia phlebophylla* H.B. Williamson, *Leptospermum grandifolium* Sm., and a variety of woody shrubs. Lichens from these host species still require identification.

Discussion

There is little published work on Australian alpine lichens, either in the form of species lists or concerning lichen assemblages and their distribution throughout the various alpine and sub-alpine habitats. A recent report combining the collections of Dr. K. Ralston and Dr. J.A. Elix (1998) recorded 62 lichens for Basalt Hill in the Bogong High Plains. Nine of these species have been identified from the Mount Buffalo collection so far. These are: *Cladonia capitellata* (Hook f. & Taylor) C. Bab., *C. pleurota* (Florke) Schaer., *C. staufferi*, *Hypogymnia lugubris* var. *sublugubris*, *Menegazzia platytrema* (Müll.Arg.) R. Sant., *Parmelia signifera*, *Rhizocarpon geographicum*, *Stereocaulon corticatulum* and *Xanthoparmelia dichotoma*. Bratt (1976) reported 57 lichens for mountain peaks and plateaus in south west Tasmania. Eight of those reported were also recorded at Mount Buffalo: *B. heteromorphus*, *C. aggregata*, *C. pleurota*, *P. signifera*, *R. geographicum*, *S. corticatulum* and *U. cylindrica*.

The work presented here suggests that different species occur in different habitats, so, different mountains may have quite distinct lichen floras. There may be, however, a set of lichens common to sub-alpine areas generally, for example, those species found by Ralston (1998) and Bratt (1976) as well as at Mount Buffalo. Mount Buffalo and Basalt Hill are quite different in terms of habitat, and the Tasmanian mountains are geographically separate, but there are species in common. With further

research, lichens indicative of Victorian sub-alpine regions may become apparent.

There are two typical alpine to sub-alpine lichens (Rogers 1992) that were not recorded on the Mount Buffalo expedition; *Thamnolia vermicularis* (Sw.) Schaer. and *Neuropogon acromelanus* (Stirt.) I.M. Lamb. *Thamnolia vermicularis* was collected from Mount Buffalo in 1946 by Pat Bibby (MEL20231), however, as no details of the exact location are given for the voucher. it is not certain whether *T. vermicularis* is now locally extinct on the Mount Buffalo Plateau. *Neuropogon acromelanus* has not been recorded at Mount Buffalo, though it may have been overlooked as it is very similar, morphologically, to the genus *Usnea*.

The lichen flora of the Mount Buffalo National Park is rich and varied, comparing favorably with other sub-alpine areas such as Basalt Hill in the Bogong High Plains. It is expected that a total species list for Mount Buffalo may number in the order of 80+ species, and the similarities between this region and others like it, may become more obvious. The potential for new records and new species is high, and further research is needed in these poorly studied alpine and sub-alpine regions.

Glossary

corticolous: living on bark
crustose: like a 'blotch' or crust and tightly attached to,or embeded in, substratum
foliose: mostly 2-dimensional, leaf-like, flat, horizontally spreading with an upper and lower surface.
sacicolous: living on, or amongst, rocks

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FNCV Buffalo Mountains Excursion, January 1978

...Another feature of granite is the darker colour on the surface than below in the undecomposed interior. The colour is not the colour of decomposed granite – it is the colour of living plants - primitive lichens – a combination of algae and fungi living in co-operation on rock and helping to break it down. The lichens are sensitive to extreme small concentrations of metals like lead, zinc, copper. Below a brass plaque near the Chalet, a white surface shows where all algae have died through rain water trickling from the brass plate over the granite surface. Similar white stripes appear below galvanized pipes set into the granite with lead plugs. We were told that the lead plugs had been covered with plastic to stop this white streak developing. Yet we humans have been drinking rainwater from galvanized roof and tanks for over 100 years without anyone complaining.

Frank Robins, *The Victorian Naturalist* **95**, 1978, 206-207.

This streaking is also seen down the side of The Horn where the safety rails have leached metals and killed all the lichen below. Editors.

Freshwater Macroinvertebrates of Mount Buffalo

John H. Hawking[1]

Abstract

The macroinvertebrate fauna of Mount Buffalo is reported from surveys and the scientific literature. Five non-insect groups and 10 insect orders were found to occur on Mount Buffalo. Where possible the distribution, biology and ecology of the common and/or ecologically interesting species is documented. (*The Victorian Naturalist* **115** (5), 1998, 215-221).

Introduction

The adults of many aquatic macroinvertebrates are highly visible and most people are familiar with this stage of the life cycle. The bushwalker acknowledges the aesthetic beauty of the brightly coloured dragonfly and the fisherman mentally notes the form of the snow-flake caddisflies which are swarming *en masse*. However, the larval or nymphal stage, which is the longest lived and most abundant stage, is completed under-water and attracts little attention or notice. The streams on Mount Buffalo, considered here as those within the Buffalo National Park, are pristine with a diverse macroinvertebrate fauna, dominated by the speciose insect orders, Ephemeroptera, Plecoptera and Trichoptera.

The species reported here are the more common and/or ecologically interesting species presently known from Mount Buffalo and this paper is not a definitive appraisal of the total aquatic macroinvertebrate fauna. The information has been obtained from my surveys, plus information provided by colleagues or available in the scientific literature. The paper is organised in phylogenetic order (most primitive to most modern) and presents five non-insect groups and 10 insect orders, and in most cases devotes a paragraph to the species of an individual family.

This paper provides an overview of the macroinvertebrate fauna and if the reader requires additional information the following literature should be consulted. A broad classification of aquatic macroinvertebrates can be made in the field by using the 'Colour Guide to Invertebrates' (Hawking and Smith 1997) or the Gould League publication 'Freshwater Invertebrates' (Miller 1996). However, scientific taxonomic keys must be used for positive identifications, and the keys are listed in Hawking (1998).

Non-Insects

Flatworms Tricladida

The flatworms are one of the most primitive macroinvertebrate groups occurring on Mount Buffalo and are represented by three species from the family Dugesiidae. *Spathula agelaea* Hay & Ball, is the most common flatworm, generally found in large clumps, but has never been found in company with *Reynoldsoni reynoldsoni* Ball, a species recorded only from the alpine area of Mount Buffalo. The third species *Cura pinguis* (Weiss), a common species throughout Australia, has been recorded from the disturbed section below The Reservoir (Hay and Ball 1979).

Mussels Mollusca, Bivalvia

The 'Pea mussel' *Pisidium casertanum* Poli, family Sphaeriidae, is commonly found in the mud and sand of pools in Running Jump Creek (Fig. 1). The mussel is small, growing up to 4 mm, burrows into the sediments, and feeds by filtering food which is ingested through a siphon.

Fig. 1. Pools in Running Jump Creek, near Wirbill Plain.

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Worms **Oligochaeta**

The aquatic worms of Mount Buffalo have not been adequately surveyed, but from the limited collections, two species *Nais communis* Piguet, Naididae, and *Lumbriculus variegatus* (Muller), Lumbriculidae, are common. *Nais communis* is a small worm, up to 5 mm and *L. variegatus* is an elongate, slender worm, up to 10 cm long, with a dark coloured body (commonly known as black worms), often found in bundles. *L. variegatus* is a European species, which was introduced as live food for fish aquaculture, but has now become widespread and common.

Mites **Acarina**

The mites are small, most less than 3 mm, and are common in most stream habitats on Mount Buffalo. They belong to four families. A species of *Flabellifrontipoda*, Oxidae, was collected from the mud/detritus from Running Jump Creek. Three species of Hygrobatidae, *Australobates mutatus* K.O. Viets, *Aspidiobates similis* Cook and *Procorticacarus angulicoxalis* (K.O. Viets), were collected from the gravels of Eurobin Creek above Lake Catani and *Hydrodroma*, Hydrodromidae, and *Barwonius*, Aturidae from submerged logs in Eurobin Creek below the falls (Fig. 2).

Yabbies, Crayfish **Crustacea**

The Isopoda and the Decapoda are the most prominent crustaceans on Mount Buffalo. The isopod, *Colubotelson joyneri* (Nicholls), Phreatoicidae, was very common in the mud/detritus of the alpine bogs and streams. The most commonly found decapods, family Parastacidae, were Murray Cray *Euastacus armatus* (von Martens), Common Yabby *Cherax destructor* Clark , and Blunt-nosed Yabby or Land-crab *Engaeus cymus* (Clark) which were found in the montane section up to 700 m, of many of the streams draining from Mount Buffalo. *Euastacus armatus* occurred in permanent flowing rivers, whereas *C. destructor* occurred in some streams, but preferred billabongs, swamps and ponds. In contrast *Engaeus cymus* is semi-aquatic and lives in burrows in the banks of streams (Horwitz 1990).

Insects

Mayflies **Ephemeroptera**

Four families of Mayflies, Letophlebiidae,

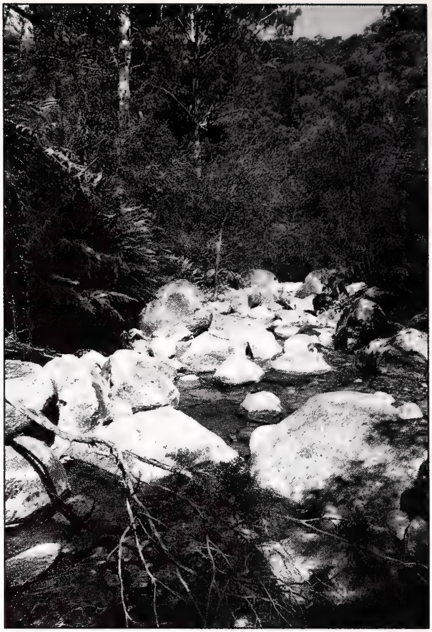

Fig. 2. Eurobin Creek, down stream of Eurobin Falls.

Baetidae, Ameletopsidae and Coloburiscidae are represented by 16 species. The most speciose family was the Letophlebiidae, with 12 species. Of these nine species occurred at Eurobin Falls, *Austrophlebioides pusillus* (Harker), *Atalophlebia* sp. AV4*, *Tillyardophlebia rufosa* Dean, *Tillyardophlebia* sp. AV3, *Neboissophlebia hamulata* Dean, *Ulmerophlebia* sp. AV2, *Koorrnga* sp. AV1, *Nousia* sp. AV2 and *N.* sp.AV4. Many of these species were also found in the alpine region, plus another three species, *Ulmerophlebia* sp. AV1 and *Garinjuga* sp. AV1 in Crystal Brook, and *Nousia* sp. AV1 in Running Jump Creek. A specimen of *Austrophlebioides pusillus* collected from Buffalo Creek, Rollason's Falls, had a larva of the chironomid *Symbiocladius aurifodinae* Hynes attached laterally to the thorax (Pl. 6B). The Chironomid parasitises the Mayfly causing reduced final growth (Hynes 1976).

Three species of the family Baetidae have been recorded from streams flowing

* Unnamed species are given Australian voucher numbers and lodged with the Museum of Victoria. This is a genus-based system, hence the repetition of numbers here.

through the mountain forest section of the lower slopes: Genus 2 sp. 1 from Eurobin Falls, and Genus 2 sp. 3 and *Bungona* sp. from Buffalo Creek, below Rollason's Falls (Phil Suter *pers. comm.*). Nymphs of *Mirawara* sp. (Ameletopsidae) were found amongst stones and cobbles of Buffalo Creek upstream of Rollason's Falls (Fig. 3.) The nymphs are predators and apparently bury into cobble substrates during the day and return to the surface at night to feed (Campbell 1980). In contrast, the nymphs of *Coloburiscoides* sp., Coloburiscidae, were found amongst cobbles and gravels in the fast current at Eurobin and Rollason's Falls, but are filter-feeders which use the fringes of setae on their fore- and midlegs to filter fine particles of food from suspension (Dean and Suter 1996).

***Dragonflies and Damselflies* Odonata**

Adult dragonflies and damselflies are conspicuous insects and are readily seen flying over the summer and early autumn months. The most common damselflies are species from the family Lestidae. *Austrolestes psyche* (Hagen in Selys) larvae are very common in the reed beds along the margins of Lake Catani (Fig. 4). *Austrolestes cingulatus* (Burmeister) tends to inhabit pools in small streams and trickles while *A. annulosus* (Selys) prefers well vegetated still waters, such as near The Reservoir. Also collected in the vegetated waters near The Reservoir were two species of the family Coenagrionidae, *Austroagrion watsoni* Leiftinck and *Ischnura aurora* (Brauer). In contrast two species *Austroargiolestes calcaris* (Fraser) and *A. icteromelas* (Selys), Megapodagrionidae, were recorded from streams. The larva of the former inhabits vegetated pools in the upper stretches of the streams, down to the elevation of Eurobin Falls, where it co-occurs with the later species, whose larvae inhabit logs and detritus.

The dragonflies were dominated by species of the family Aeshnidae (7 species). *Austroaeschna flavomaculata* Tillyard occurred on the stream bed or amongst marginal vegetation, while *Austroaeschna parvistigma* Selys occurred in rock pools, with dense growths of submerged vegetation, in small alpine streams. Three species were common in the streams flowing down through the mountain forests, with *A. atrata* Martin occurring on logs, *A. pulchra* Tillyard in the gravels and *Notoaeschna sagittata* (Martin) clinging to the underside of rocks. In contrast *Hemianax papuensis* (Burmeister) was a common species amongst the rush beds on the western margin of Lake Catani, whereas *Aeshna brevistyla* Rambur generally occurred in more densely vegetated still waters.

The larvae of *Synthemis eustalacta* (Burmeister), Sythemistidae, (Pl. 6C) inhabits areas of mud/detritus in the alpine bogs and streams. Of two cosmopolitan species of Corduliidae, *Hemicordulia tau* Selys, were very common at Lake Catani, while adults of *Procordulia jacksonensis* (Rambur) were found flying over the alpine marsh pools. The family Gomphidae is represented by *Austrogomphus guerini* (Rambur), whose larvae inhabit the gravel/cobble substrate of Eurobin Creek above Lake Catani. The adult is recognisable by the continuous yellow stripe on all abdominal segments.

Fig. 3. Rollason's Falls. Photo by Sharon Ford, January 1998.

Fig. 4. Reed beds on the western edge of Lake Catani.

***Stoneflies* Plecoptera**

Species of the four Australian families (Eustheniidae, Austroperlidae, Gripopterygidae and Notonemouridae) have been recorded from Mount Buffalo. Species of the family Eustheniidae are distinguished by their white lateral gills on the first 5 or 6 segments. The most commonly found species is *Cosmioperla kuna* (Theischinger), a large nymph, final instar 25-38 mm long, occurring on loose stones in larger streams, such as Buffalo Creek (Hynes 1978).

Two species of Austroperlidae, *Austropentura victoria* Illies and *Acruroperla atra* (Samal), are common in most stony streams on Mount Buffalo. Austroperlid larvae are recognised by the presence of 5–7 beaded gill filaments, which includes the cerci. The nymph of *Austropentura victoria* is medium sized (final instar, 17–20 mm long) with three gills, plus cerci, a total of five beaded filaments and pale spots on the abdomen, whereas the nymph of *Acruroperla atra* is readily identified by the distinctive paired abdominal protuberances.

The Gripopterygidae nymphs are identified by the presence of a bunch of anal gills. The most commonly collected species was *Eunotoperla kershawi* (Tillyard), a large species 16–18 mm long, which occurred on large stones in the swift current (Hynes 1978). In contrast the Notonemouridae nymphs all lack gills and the sterna of abdominal segments 2–9 are divided into upper and lower segments. The nymphs of *Austrocerca tasmanica* (Tillyard) (Pl. 6D), *Austrocercella alpina* Theischinger (a species restricted to only alpine regions), and *Austrocercella communis obtusa* Theischinger (Eurobin Creek is the 'Type locality'), are common in most of the fast flowing streams.

***Bugs* Hemiptera**

Aquatic bugs are opportunists which move between water-bodies, generally inhabiting still waters and backwaters or margins of streams. The families can be separated into three ecological groups: fully aquatic, shore-dwelling and surface-dwelling. The fully aquatic bugs are represented by the Water Boatmen Corixidae, with *Sigara sublaevifrons* (Hale) generally the most abundant species and the Back Swimmer *Anisops*, Notonectidae, which was very common in Lake Catani.

The surface dwelling families, Water Striders Gerridae, Small Water Strider Veliidae and Water Treaders Mesovelliidae have been collected at Mount Buffalo. *Tenagogerris euphrosyne* (Kirkaldy), Gerridae, has been collected from The Reservoir and Upper Rose River and a species, *Mesovelia*, Mesovelliidae, has been collected from the waters of The Reservoir (I. Endersby *pers. comm.*). Three species of *Microvelia*, Veliidae, have been recorded: *Microvelia peramoena* Hale from The Reservoir, possibly the most common species, *M. oceanica* Distant from the Buckland Valley and *M. fluvialis fluvialis* Malipatil from the Buffalo River Valley (Malipatil 1980).

***Alderflies, Dobsonflies* Megaloptera**

The larvae of a species of *Archichauliodes*, Corydalidae, is common on the undersides of rocks or amongst debris in the fast flowing streams. The larvae are distinguished by the large powerful prey-capturing mandibles and the eight pairs of lateral gills.

***Lacewings* Neuroptera**

There are most likely other species of Neuroptera from Mount Buffalo, but I have only collected larvae of a species of *Kempynus*, Osmylidae, from under stones and damp litter amongst logs on stream margins at Eurobin Falls. The larvae are semi-aquatic carnivores and can be distinguished by their very long straight mandibles and maxilla, which are much longer than the head.

***Beetles* Coleoptera**

Five families (Dytiscidae, Hydrophilidae, Elmidae, Scirtidae and Gyrinidae) were collected from Mount Buffalo. Adults of the predacious diving beetles dytiscids *Antiporus femoralis* (Bohemman), *A. gilberti* (Clark), and *Rhantus suturalis* (W. MacLeay) were collected from pools on Eurobin Creek, above Lake Catani. Both the adults and larvae are aquatic and are found swimming and diving in the edge zone of still and flowing waters. Also in the same pools was the larvae of an unknown species of marsh beetle, Scirtidae and two species of water scavenging beetles, *Enochrus mastersi* (W. MacLeay) and *Notohydrus* sp., Hydrophilidae. The two hydrophilid species have a widespread distribution and are common in still waters. Only the larval stage of the scirtids

is aquatic and these larvae can be recognised by their multisegmented antennae.

The larvae of two Riffle Beetles, Elmidae, *Notriolus maculata* Carter and *Kingolus yarrensis* Carter & Zeck were collected from Mount Buffalo. *Notriolus maculata* is a wood-chewing species which was found in grooves in submerged logs at Eurobin Falls. In contrast *K. yarrensis*, a grazer, occurred as an adult and larva in the submerged roots of native bushes growing on the edges of the stream at Dicksons Falls (Fig. 5). In contrast to the benthic dwellers is the Whirligig Beetle *Macrogyrus*, Gyrinidae, which swims on the surface and was very common in late summer. The adults have their eyes divided into an upper and lower section, which allows them to see above and below the water's surface simultaneously.

***Scorpion-flies* Mecoptera**

The larvae of the scorpion-flies from Mount Buffalo have not been associated with a described adult and can only be identified to the genus *Nannochorista*, Nannochoristidae. The larvae are elongate, 16–20 times as long as their diameter, with a heavily sclerotised head and pronotum and are very common in the mud/detritus in the bogs and pools of Running Jump Creek.

***True-flies or Two-winged-flies* Diptera**

The 'flies' are generally the first insect to greet visitors to Mount Buffalo during the warmer months, and are remembered for their nuisance value and/or painful bites. Many of these species have aquatic larvae and representatives of some of the more common families found on Mount Buffalo are presented below.

The adults of the families Biting Midges Ceratopogonidae, Black Flies Simuliidae and Mosquitoes Culicidae are the common nuisance species. The larvae of the ceratopogonid, *Bezzia* sp., are thin worm-like animals which are found in the detritus of pools and bogs of streams, being common in Running Jump Creek. Also occurring in this creek is the simuliid, *Austrosimulium furiosum* (Skuse), which can be found usually attached to plants and rocks. In contrast, the Mosquito larvae of *Aedes notoscriptus* (Skuse) were plentiful in rock-pools at Dicksons Falls and the adults sheltered in the shaded areas near the falls.

Two other interesting families are the Craneflies Tipulidae and the Athericidae, which both were found in the bogs and pools of the alpine streams, especially Running Jump Creek and Dingo Dell Creek. The tipulids could only be identified to the subfamilies Limoniinae and Tipulinae, and the athericid to the genus *Dasyomma*.

Blephariceridae larvae are unusual, differing from the generalised larval form in that they are flattened, and comprise six principal divisions, each with a well-developed sucker ventrally (Pl.6E, 6F). The larvae attach to rocks of swiftly flowing streams and graze on the algae attached to the rocks. Zwick (1977) recorded 3 genera, with 7 species from Eurobin Creek, near and below the falls; *Edwardsina pilosa* Zwick, *E. bubalus* Zwick (Type locality), *E. williamsi* Zwick, *E. torrentium* Zwick, *Edwardsina* sp. A, *Austrocurupira nicholsoni* (Tillyard) and *Apistomyia tonnoiri* Tillyard.

Species of three subfamilies of non-biting midges, Bloodworms Chironomidae Chironominae (*Polypedilum*, *Tanytarsus*, *Rheotanytarsus*), Tanypodinae (*Paramerina*, *Ablabesmyia*) and Orthocladiinae

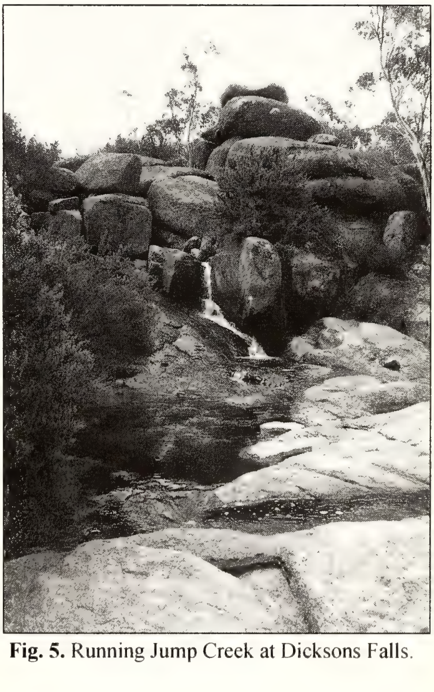

Fig. 5. Running Jump Creek at Dicksons Falls.

(*Cricotopus*, *Paralimnophyes*) have been collected from Running Jump Creek. The larvae of *Polypedilum* are shredders which feed on plant material, whereas the larvae of *Rheotanytarsus* are tube-dwellers, which attach to wood or stones and collect/ filter food caught in a net at the outer end of the tube. Another interesting Chironominae species, found in the Buckland River, is *Imparipecten pictipes* Freeman, Chironominae, whose larva is a true wood-miner, forming excavated galleries in immersed wood (Cranston and Hardwick 1996). The other two subfamilies also show major feeding differences. *Paramerina* is a predator which engulfs its prey, while *Cricotopus* feeds by scraping attached algae from rocks, plants etc.

***Caddis-flies* Trichoptera**

The Trichoptera are very diverse at the family level, with more than 11 families occurring on Mount Buffalo. Many families are speciose (Leptoceridae and Hydrobiosidae), but most contain a single species or only a few species. Likewise the family Calamoceratidae is represented by a single species of the genus *Anisocentropus*, whose larvae are readily distinguished by their flat case made of only two pieces of leaf material (St Clair 1997). *Archaeophylax* is the only Australian genus of Limnephilidae and the larvae from Mount Buffalo are of one or both, of the two species recorded from Victoria. The larvae collected from Eurobin Creek, above Lake Catani and Dingo Dell Creek were moderately large, up to 20 mm, with cylindrical, slightly curved cases consisting of plant materials. Another species which has a similar case, being very broad anteriorly, strongly curved, constructed of small sand grains, but considerable smaller (up to 5 mm) is *Austrheithrus* sp., Philorheithridae. The larvae can be recognised by the fused tibia and tarsus of the mid leg. They are predators and are always found in low numbers (St Clair 1997).

Plectrocnemia sp. AV1, Polycentropodidae, was found in the alpine region, at Dingo Dell and Running Jump Creek. Its larvae construct retreats of a loose silken net on rocks (Cartwright 1998). Another related family is the Ecnomidae, of which larvae of a species of *Ecnomina* were collected from Buffalo Creek, below Rollason's Falls (Phil Suter *pers. comm.*). *Ecnomina* larvae are predatory, free living and construct fixed tubes or retreats of silk on rocks or logs (Cartwright 1997).

The family Leptoceridae is represented by at least four genera, with ten species. Four species of *Notolina* were recorded, *N. fulva* Kimmins and *N. spira* St Clair have both been found associated with detritus and macrophytes in The Reservoir and *N. ordina* St Clair was found at Eurobin Falls with *N. bifaria* Neboiss in a small creek below The Reservoir. *N. bifaria* is associated with the riparian vegetation, usually near the water surface, whereas the other three species are benthic dwellers (St Clair 1991). *Notoperata maculata* (Mosely), *Triplectides elongatus* Banks and *T. varius* Kimmins are all found in sphagnum bogs and alpine creeks above 1500 m on Mount Buffalo. *Lectrides varians* Mosely and *T. ciuskus* Mosely are reported from a wide range of habitats and at Mount Buffalo were found at Lake Catani (St Clair 1994). In contrast *T. truncatus* Neboiss was only collected from Eurobin Falls, at a much lower elevation than the other species.

A species of *Helicopsyche* (only Australian genus of Helicopsychidae) was collected from Eurobin Falls and near Rollason's Falls (Phil Suter *pers. comm.*). The larvae are easily recognised by their small (up to 6 mm) helical case and were usually found on stones where they grazed on algae.

Two species of Hydropsychidae were found: *Asmicridea* sp. AV1 (Eurobin Falls and Crystal Brook) and *Diplectrona* sp. AV2 (Eurobin Creek, at the Falls and at the underground river, downstream of Lake Catani) (John Dean *pers. comm.*). The hydropsychid larvae are readily distinguished by their conspicuous branched abdominal gills and their three sclerotised nota. The larvae construct retreats, of plant and mineral material, with an upstream entrance organised into a capture net which filters food particles.

Eight species of Hydrobiosidae have been collected from Mount Buffalo and were very common at the following sites: Eurobin Falls, *Psyllobetina attunga* Neboiss, *Ulmerochorema rubiconum* group, *U. seona* (Mosely), *Taschorema evansi* Mosely, *Ethochorema turbidum* (Neboiss); Eurobin Creek upstream of

Lake Catani, *Apsilochorema obliquum* (Mosely), *Koetonga clivicola* Neboiss, *E. turbidum*, *Ptychobiosis* sp.; Crystal Brook, Reservoir Road, *U. rubiconum* gp., *T. evansi*, *E. turbidum*, *Ptychobiosis* sp. (John Dean *pers. comm.*). The hydrobiosid larvae are predacious and free living, and are reported to trail a silken thread which is attached to the substrate (Dean 1997).

Two species of Philopotamidae, *Hydrobiosella waddama* Mosely and *Chirmarra monticola* Kimmins (Pl. 6G) occurred in both the alpine and forest streams on Mount Buffalo. Their larvae construct silken tubes or sack-like nets on the underside of rocks in flowing water. They feed by cleaning the fine detritus and algae from the net with their highly specialised labrum. The labrum is membranous, a feature which distinguishes the larvae (Cartwright 1997).

Three species of Hydroptilidae, *Hellyethira simplex* (Mosely), *Oxyethira columba* (Neboiss) and *Orthotrichia* sp. were all collected from Running Jump Creek. *Hellyethira simplex* constructs a more or less rectangular case built of secretions, and is found attached to rocks amongst filamentous green algae. *Oxyethira columba* secretes a flask-shaped case (Pl. 6H), which it attaches to rocks amongst filamentous green algae. The final instar larvae of the Mount Buffalo species of *Orthotrichia* have a very small head and a body that resembles a 'honey-pot' in an elongate case with rounded ends. The pupae don't attach to rocks as do those of many other hydroptilids, but parasitise the pupae of hydropsychids and philopotamids (Alice Wells *pers. comm.*).

Acknowledgements

I would like to thank the following colleagues for confirming identification: David Cartwright (Trichoptera), John Dean (Ephemeroptera and Trichoptera), Alena Glaister (Elmidae), Jane Growns (Acarina), Peter Hancock (Acarina), Daryl Neilsen (Chironomidae), Adrian Pinder (Oligochaeta), Phil Suter (Ephemeroptera), Alice Wells (Hydroptilidae), Chris Watts (Coleoptera) and Buz Wilson (Phreatoicidae). Phil Suter, John Dean and Ian Endersby are also thanked for supplying distribution records, and special thanks to Mike Copland for proof reading the drafts and to the unknown referees.

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The Butterflies of Mount Buffalo National Park

D.F. Crosby[1]

Abstract

A list of 30 species of butterflies recorded from Mount Buffalo, Victoria, is provided with brief notes on each. Some suggested explanations of how the now widely separated colonies of some Australian alpine butterflies may have evolved are given. (*The Victorian Naturalist*, **115** (5), 1998, 222-225).

Introduction

The butterflies of this park have been studied superficially by several collectors over the last 70 years. However, in 1975, I produced a preliminary list covering 17 species (Crosby 1975), and Dunn and Hunting (1983) extended this to 21. The butterfly fauna at Mount Buffalo may be roughly divided into two groups: those found in the lower, non-alpine areas at the base of the mountain such as around Eurobin Falls, and the alpine and subalpine areas on the plateau (about 1200 m) and its prominences.

Surveying the park has been, and still is, difficult with the necessity of obtaining study permits with increasing levels of conditions from the Department Natural Resources and Environment. Nevertheless, the park habitat and butterfly fauna is interesting as it is separated from neighbouring alpine areas by about 40 km of low land.

Species recorded

Family Hesperiidae **(Skippers)**

Mountain Skipper *Anisynta monticolae* (Olliff). Recorded from open, sunny rock faces in January. Not common. The larvae feed on Slender Tussock-grass *Poa tenera* (Poaceae) (N. Quick *pers. comm.*).

Dominula Skippper *A. dominula drachmophora* (Meyrick). Common in sunny, grassy areas, such as around Lake Catani, in February to mid-March. Dunn and Hunting (1983) note the absence of this species from other typical habitats on the mountain and I could confirm this. The larvae feed on Snow Grass *Poa* spp., mainly *P. hiemata* and *P fawcettiae* (N. Quick *pers. comm.*).

Dispar Skipper *Dispar compacta* (Butler). Usually found in sunny, open forest, in non-alpine areas December–March.

Bright Shield Skipper *Signeta flammeata* (Butler). A widely distributed and common species found in the non-alpine areas, with larvae feeding on soft grasses.

Flame Skipper *Hesperilla idothea idothea* (Miskin). Also a widely distributed, common species in the non-alpine areas, where the larvae feed on various species of Saw-sedge *Gahnia* spp. Dunn and Hunting (1983) note males at The Horn.

Family Papilionidae **(Swallowtails)**

Macleay's Swallowtail *Graphium macleayanus macleayanus* (Leach). A strong flier which often frequents prominent peaks, such as The Horn, in January, but breeds in the damp gullies where its larvae feed on Southern or Black Sassafras *Atherosperma moschatum*.

Family Pieridae **(Whites)**

Small Grass Yellow *Eurema smilax* (Donovan). A single specimen of this migrant species was observed near Lake Catani in March.

Wood White *Delias aganippe* (Donovan). Also a strong flier, found hill-topping at The Horn in January with *G. macleayanus. Delias aganippe* larvae feed on various mistletoe species *Amyema* spp.

Caper White *Belenois java teutonia* (Fabricius). This is a wide-ranging, migratory species not breeding in Victoria due to the lack of its food plant, the Caper *Capparis* spp. The species is usually seen after Christmas, often having been blown to the area by strong north winds.

Common Albatross *Appias paulina ega* (Boisduval). Another migratory species, but much rarer, occasionally seen in years favourable to its breeding which occurs outside Victoria.

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Cabbage White *Pieris rapae* (Linnaeus). An introduced species found commonly over the whole of the State.

Family Nymphalidae,
***Subfamily Satyrinae* (Browns)**

Cyril's Brown *Argynnina cyrila* Waterhouse & Lyell. Flies in the lower areas in spring and Dunn and Hunting (1983) note it in Snow Gum *Eucalyptus paucifloris* forest clearings.

Southern Ringed Xenica *Geitoneura acantha* (Guest). Seen in shady, damp areas around the base of the mountain.

Klug's Xenica *G. klugii klugii* (Guérin-Méneville). Flies in sunny areas in open non-alpine forest December–February.

Shouldered Brown *Heteronympha penelope penelope* Waterhouse. A strong flier found in the lower non-alpine areas as well as the alpine and sub-alpine areas in February and March.

Bank's Brown *H. banksii banksii* (Leach). This species is found from sea-level to the mountain tops. It flies in later February and March.

Solander's Brown *H. solandri* Waterhouse. Only found in the alpine areas, mainly in January.

***Oreixenica latialis theddora* Couchman** (Pl. 5B, 6A). Only found in the open, grassy alpine areas from late February to the end of March. **This subspecies only occurs on the Buffalo plateau**, principally around Lake Catani, flying with *O. lathoniella* (Pl. 5A) which it closely resembles both in appearance (Common and Waterhouse 1981) and flight. Dunn and Dunn (1991) confirm the distinctness of this subspecies and provide details of the other subspecies.

Common Silver Xenica *O. lathoniella herceus* Waterhouse & Lyell (Pl. 5A). This widely distributed and attractive species is much commoner than *O. latialis*, which flies at the same time, and is found in moist forest areas from sea-level to the mountain tops.

Correa Brown *O. correae* (Olliff). This is another widely distributed and common species, but is only found in alpine areas, from late January to March.

Swordgrass Brown *Tisiphone abeona albifascia* Waterhouse. This graceful, dark insect is found flitting around *Gahnia* plants, on which its larvae feed, or flying strongly in moist open forest up to sub-alpine habitats January–March.

***Subfamily Nymphalinae* (Nymphs)**

Painted Lady *Vanessa kershawi* (McCoy). This well-known and very widely distributed species is found from the coast to the mountains throughout the warmer months.

Australian Admiral *V. itea* (Fabricius). This is similar to the preceding species, but generally not found above the sub-alpine areas. The larvae feed on nettles (family Urticaceae).

Meadow Argus *Junonia villida calybe* (Godart). Also a common species, occasionally seen in sub-alpine habitats. The larvae feed on Plantains (family Plantaginaceae).

***Family Lycaenidae* (Blues and Coppers)**

Bright Copper *Paralucia aurifer* (Blanchard). A possible sighting was made near the foot of the mountain, but confirmation is required. The species is a fast flier and its larvae feed on Sweet Bursaria *Bursaria spinosa*. The adults are often seen flying around flowering food plants in December and January.

Common Imperial Blue *Jalmenus evagoras evagoras* (Donovan). This attractive species is common, but local in both open forest and heaths where there are low bushes of a number of Acacias, on which the larvae feed gregariously. It flies from mid-December to March, but only in non-alpine areas.

Rayed Blue *Candalides heathi heathi* (Cox). There is a single record of a male caught in January 1933, but this requires confirmation.

Fringed Blue *Neolucia agricola agricola* (Westwood). The larvae of this species feed on many varieties of Pea flowers (family Fabaceae) and it has been found near the Chalet in January. It is usually found in plains sheltered by Eucalypts under which the food plants grow.

Mountain Blue *N. hobartensis hobartensis* (Miskin). A single female was caught in February 1958. The present existence of the species on the mountain requires confirmation, although the species usually occurs in the higher alpine areas.

Common Grass-blue *Zizina labradus labradus* (Godart). This widely distributed species is common throughout the State, being found from sea-level to sub-alpine areas from spring to autumn.

Discussion

The above fauna is what would be expected from this type of area, combining alpine, sub-alpine and non-alpine habitats. There are some species that one would have expected but have not been recorded so far, probably due to lack of thorough searching at the right time of year.

The only significant butterfly recorded is *Oreixenica latialis theddora* (the subspecies is confined to Mount Buffalo). *Oreixenica latialis* usually flies with *O. lathoniella*, as is recorded here, which in other areas it follows the usual January flight of the allied *O. orichora*, which, however, is absent from Mount Buffalo. Joint colonies of *O. latialis* and *O. orichora* are found on the Bennison High Plains, north of Licola, and at Mount Hotham, as well as at several locations around Mount Kosciusko. On the other hand, there are colonies of *O. orichora* without *O. latialis* on Mount Buller.

A study of the patchy distribution of the mountain species of *Oreixenica (correeae, latialis, orichora* and *lathoniella*) raises the interesting question as to why *O. latialis* and *O. orichora* are only found in widely separated alpine areas above an altitude of about 1350 m. I believe that the explanation for this goes back to the time following the end of the last world-wide ice age about 10-15 000 years ago. During that ice age Australia had a small ice sheet over part of the Kosciusko area and in Tasmania, so that, low temperatures in the present mountain areas of Victoria would have meant that alpine habitats could have existed at elevations as low as a few hundred metres. Alpine species of both insects and plants would have migrated down into these locations which would have occupied the valleys and extended for substantially greater distances than they do currently. The butterflies would have spread widely into these new habitats and gradually stabilized.

At the end of the ice age, as the temperatures increased, the extensive low-level 'alpine' communities of plants and insects would have to either adapt to the higher temperatures, or move to higher elevations supporting similar conditions to those which had existed lower down. Species such as *O. latialis* and *O. orichora* were unable to adapt to warmer conditions and thus, died out at lower altitudes. On the other hand *O. lathoniella* did adapt, remained in the lower areas and further expanded its range and also moved to higher altitudes, following the alpine conditions. *Oreixenica correae* appears to represent a similar situation to *O. latialis* and *O. orichora*.

It is interesting that there is a range of plants found both in alpine habitats and in low-level habitats, which are sunny, damp or water-logged with low-nutrient, acid soils, in heathland or grassland in open forest. Examples are not found in intervening localities. These observations appear to support the hypothesis that alpine plants and insect communities may have migrated up and down mountains with the rise and fall in temperatures associated with the arrival and departure of the ice ages.

However, another explanation of the current distributions is that strong and persistent winds could have blown numbers of specimens between the mountain tops to where suitable habitats existed. I feel that the distances concerned (40–60 km), the restricted nature of the habitats, the need for the wind to be blowing in exactly the right direction at the correct time of year, the fragility and small size of the butterflies and the low level of the land separating the peaks, would argue against this explanation.

There may be other explanations for these distribution patterns but I will leave them to the expert biogeographers. There may be genetic influences as well, but I think that as most of the separated populations are identical, the influences have been relatively recent.

The current significance of the alpine insect faunas, and particularly species restricted to that habitat, is that they will be the first to be affected by any global warming produced by the 'greenhouse effect'. Setting baselines for present conditions (particularly temperature and humidity) and monitoring for longer term changes in the populations could be an important indica-

tion of the real establishment of the effect.

From the conservation aspect, New (1997) discussed the significance of closed populations such as those of the mountain-top species with widely separated colonies, and cites *O. latialis* as an example. He mentions the increased pressures on species in this habitat due to tourism and winter sports facilities. The vulnerability of butterflies is increased through their restricted areas of acceptable habitat and lack of dispersal powers. This needs to be carefully considered before the habitats are disturbed.

Achnowledgements

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The Tatra Inn Insect Displays

About 12–15 years ago, David Holmes of Dromana, Victoria, prepared two boxes of butterflies and moths typical of the alpine areas of Victoria for the Department of Conservation. David Holmes recently confirmed that these displays were not intended to show the insects of a specific area, such as Mount Buffalo. If it has been labelled as a display of the butterflies of Mount Buffalo, this is incorrect and should be altered. Some confusion seems to have developed from that display because it contained the following species which have not been found on Mount Buffalo:

Family Hesperiidae,
- Alpine Skipper *Oreisplanus munionga* (Oliff);

Family Pieridae,
- Imperial White *Delias harpalyce* (Donovan);

Family Nymphalidae,
- Common Brown *Hereronympha merope merope* (Fabricius);
- Bright-eyed Brown *H. cordace cordace* (Geyer);
- Orichora Brown *Oreixenica orichora* (Meyrick).

In addition, there is a specimen incorrectly identified as *Oreixenica paludosa theddora* – the species *O. paludosa* was confused with *O. latialis* at that time – but the label data indicates that this specimen came from Mount St Bernard (Bogong National Park), so that it would be Alpine Silver Xenica *O. latialis latialis*, as *O. latialis theddora* is confined to Mount Buffalo.

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Natural History Notes at the General Meeting of the FNCV 14 January, 1904

Mr D. Best remarked on the enormous quantities of the common white butterfly, *Belenois java*, Spar., usually known as *Pieris teutonia*, Fab, on the Buffalo Mountains, where they appeared in thousands.

Mr J.A. Kershaw, F.E.S., stated that these butterflies were unusually numerous this season almost all over the State. They were to be seen almost every day flying along some of the principal streets in the city and suburbs. Sydney entomologists has also remarked on the large numbers in that State. In answer to a question, Mr Kershaw stated that the larvae of this species feed on the leaves of *Capparis mitchelli*.

The Victorian Naturalist **20**, 1904, 115.

The butterfly is referred to in the above paper as Caper White *Belenois java teutonia* (Fabricius)

Aquatic Microfauna from Lake Catani and Environs, Mount Buffalo National Park

Russ Shiel[1] and Jackie Griggs[1]

Abstract

Zooplankton-net trawls from Mount Buffalo reservoir, Lake Catani, and five streams in the surrounding area yielded 75 taxa of microfauna (testate rhizopods, rotifers, microcrustacea) and eight taxa of small macroinvertebrates. Most taxa are new records for the National Park. At least seven testates and one rotifer apparently are new records for Australia. Of seven sites sampled, Lake Catani had the most diverse microfauna (32 taxa), otherwise species diversity was low. There was little similarity in microfaunal assemblages between sites. (*The Victorian Naturalist* **115** (5), 1998, 226-230).

Introduction

Sporadic references to plankton collections from Victoria's high country occur in widely scattered literature. Lake Catani, in Mount Buffalo National Park (Fig. 1) has been sampled occasionally (e.g. Smirnov and Timms 1983). Lake Buffalo, just outside the park, was sampled seasonally in the late 1970s (Shiel 1981). Published records of aquatic microfauna from the region remain sparse.

To provide preliminary information on aquatic microfaunal communities of the Mount Buffalo region, we sampled in autumn 1997 and in summer 1998. The microfaunal groups of interest were testate rhizopods (see also Meisterfeld and Tan 1998, this issue), rotifers, copepods and cladocerans, most of which are <1 mm in size.

Sampling sites

Sites from which plankton/littoral microfauna were collected are shown on Fig. 1. Two open water sites (>1 m depth), Buffalo Reservoir (site 2) and Lake Catani (site 3) were trawled on January 10, 1998. A net tow was also taken through emergent reeds on the Lake Catani margin (80 cm depth). *Sphagnum* beds of the Lake Catani littoral were sampled for chydorid cladocerans in April 1997 (by J.G.). Tows also were also collected in January from five stream sites in three catchments within the Park: NE-flowing Eurobin Creek (site 1), Crystal Brook, a tributary (site 7), Dingo Dell, above Lake Catani (site 6), Running Jump Creek (site 5) at Tatra Inn, which is a tributary of the SW-flowing Bunyip Creek, and a small eastward flowing stream at Lyrebird Plain (site 4). Crystal Brook was the widest and deepest of the stream sites at the time, c. 1 m × 30 cm, over a gravel substratum. The other four stream sites were shallow (<20 cm) narrow rivulets between mossy banks, with fine black organic material substrata.

Methods and Materials

Qualitative pelagic (open water) hauls of c. 10 m were made with a standard cone-net, aperture 20 cm, mesh size 53 µm. Littoral and shallow stream samples were collected using a Frey net - a long-handled, extendable cone net, 14 cm aperture, 37 µm-mesh, with a 4 mm-mesh stainless steel grille across the aperture to limit ingress of debris. Sweeps with this net generally were only 3-4 m. The filtered volume in each case was concentrated using the collecting net to c. 20 ml, which was then preserved using 75% ethanol to a final volume of 60 ml.

In the laboratory, samples were sorted on a Zeiss SV-8 dark-field dissecting microscope. Where necessary, dissections of limbs for identification of copepods and cladocerans were performed on this microscope, using electrolytically-sharpened tungsten needles. Erosion of rotifer tissues to expose species-specific trophi (dentition) was by means of sodium hypochlorite beneath coverslips on the stage of an Olympus BH-2 compound microscope with Nomarski optics. In each case the process was recorded on video. Photographs of representative taxa included here were taken on the BH-2 using a microscope-mounted Sony S-VHS video camera and printed via a Sony CVP-G700 video printer. Higher resolution micrographs were taken of selected specimens prepared and mounted for scanning electron microscopy. Taxonomic keys used to identify testates include Ogden and Hedley (1980) and Ellison and Ogden (1987) and the references therein. Rotifers and cladocerans were identified using keys in Koste (1978) or Shiel (1995). Copepods

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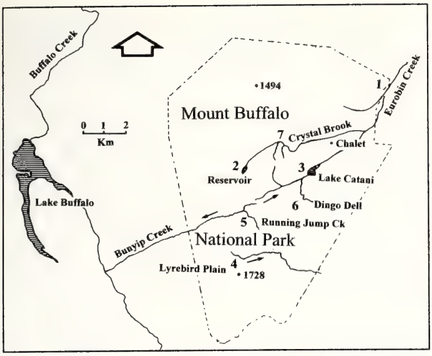

Fig. 1. Microfaunal sampling sites, Mt Buffalo National Park. ---- boundary of National Park; arrows show direction of stream flow.

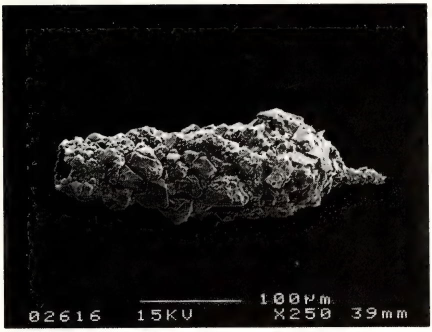

Fig. 2. A characteristic test of *Difflugia acuminata* (Rhizopoda), built from sand grains (scanning electron micrograph).

were identified using keys in Bayly (1992) and Dussart and Defaye (1995).

Results and Discussion

Table 1 lists the microfauna identified from each site. A further eight macroinvertebrate taxa smaller than 4 mm managed to fit through the mesh over the Frey net. They were: naidid oligochaetes, turbellarians, bivalve (*Corbiculina* sp.) and gastropod molluscs, chironomid and simuliid dipteran larvae, a trichopteran larva, and hydracarinid mites. Notably, all occurred at site 6, Dingo Dell, where fringing *Sphagnum* was sampled by the net sweep, but otherwise only a few chironomid/ simuliid larvae occurred in the samples from Buffalo Reservoir, Eurobin Creek, and Running Jump Creek. One other sample, from Lyrebird Plain, contained several naidid oligochaetes. Although the macroinvertebrates recorded are beyond the scope of this study, they are noteworthy in that their inadvertent collection suggests a diverse array of grazers and predators in the macroinvertebrate communities of at least some of the Mt Buffalo sites.

The 75 microfaunal taxa listed in Table 1 comprise testate amoebae, rotifers, and microcrustacea (copepods, cladocerans and ostracods). Twenty-five testate taxa could be discriminated, although some remain to be fully identified. *Difflugia acuminata* (Fig. 2) and an unidentified *Difflugia* sp. were the most commonly encountered species, both occurring at three sites. Only one-third of the testates found in the January series were recorded by Meisterfeld and Tan in 1998 (this issue), probably reflecting both intra-habitat heterogeneity and temporal succession in the rhizopod community. Most of the remaining testates listed in Table 1 are first records for Mount Buffalo, with seven taxa apparently new records for Australia. The considerably lower testate diversity we recorded from some of the sites also sampled by Meisterfeld and Tan (1998) reflects both the habitat preferences of the organisms, and the selectivity of our sampling method. Testates are primarily epiphytic or epibenthic in habit, hence are less likely to be encountered in the pelagic zone of deep waters, or in the open water of streams. Those we did collect are likely to be incidental incursions, washed from substrata by current, or dislodged from substrata by our net sweeps, particularly in the Lake Catani samples.

Rotifer diversity was low; even in the most speciose site, Running Jump Creek, only 10 rotifer species were recorded. In contrast, >100 species of rotifer are known to co-occur in wetlands of Murray tributaries (Shiel *et al.* 1998), yet only 27 taxa of rotifers were found from all Mount Buffalo sites. All appear to be first records for Mount Buffalo, with all but one previously recorded from Australia. The notable exception, *Rousseletia corniculata* Harring, 1913 (Pl. 4D) is recorded from Australia and the southern hemisphere for the first time. It was previously known only from the northeast of the U.S.A. (Koste 1978). It is likely that considerably more rotifers will be found in the National Park with more intensive, particularly seasonal, sampling.

Copepoda similarly were not diverse, with only nine taxa recorded from all sites, although they were numerically abundant in the two deep water sites. The common centropagid calanoid *Boeckella triarticulata*

Table 1. List of species of testate rhizopods, rotifers, microcrustacea and macroinvertebrates recorded from seven sites in Mt Buffalo National Park. # = new record for Australia **Site: R**=Buffalo Reservoir; **C**=Lake Catani 1998; **E**=Eurobin Creek; **B**=Crystal Brook; **L**=Lyrebird Plain; **J**=Runing Jump Creek; **D**=Dingo Dell; **Z**=Lake Catani 1997. @ = juvenile, not identified, not included in total.

Site	R	C	E	B	L	J	D	Z
Taxon								
Rhizopoda								
Arcella catinus							+	
Arcella gibbosa#		+						
Arcella vulgaris		+						+
Arcella sp. a		+						
Arcella sp. b								+
Centropyxis cf. cassis#								+
Centropyxis sp. a		+						
Centropyxis sp. b			+					
Cyphoderia trochus#						+		
Difflugia acuminata		+					+	+
D. cf. bicornis#							+	
D. cf. distenda #		+						
D. cf. globulosa			+					
D. labiosa#								+
D. cf. lebes#			+					
D. oblonga								+
D. penardi						+		
D. varians		+						
Difflugia sp. a		+						
Difflugia sp. b					+	+	+	
Euglypha sp.		+					+	
Lecquereusia modesta		+				+		+
Lecquereusia sp.								+
Netzelia oviformis		+						
Zivkovicia compressa			+			+		
Rotifera								
bdelloid cf. Rotaria sp.	+							
Anuraeopsis navicula		+						
Ascomorpha ovalis		+						
Ascomorpha sp.	+							
Asplanchna sieboldi	+							
Cephalodella gibba						+		
C. gibba microdactyla						+		
Cephalodella sp.		+				+		
Colurella sp.	+							
Conochilus sp.	+							
Dicranophorus sp.						+		
Euchlanis incisa							+	
Euchlanis sp.				+	+			
Keratella procurva								
Keratella tropica		+						+
Lecane flexilis	+					+		
Lecane cf. lunaris	+							
Lecane sp.		+						
Lepadella acuminata	+							
L. patella						+		
Monommata dentata						+		
indet. notommatid				+				
Ploesoma lenticulare w. diatoms		+						
Polyarthra sp.		+						
#Rousseletia corniculata A83						+		
Trichocerca insulana						+		
Trichocerca tigris						+		
Copepoda								
Calanoida								
Boeckella triarticulata	+							
Cyclopoida								
Eucyclops nichollsi	+							
Eucyclops sp.	+							
Mesocyclops sp.						+		
Metacyclops sp.	+	+						
Microcyclops sp.		+						
Tropocyclops sp.		+						
Cyclopidae			+	+	+	+	+	
Harpacticoida								
Canthocamptidae		+					+	
indet.copepod nauplii@					+	+	+	
Cladocera								
Bosminidae								
Bosmina meridionalis	+	+						
Chydoridae								
Alona cf. guttata tuberculata	+	+						
Alonella excisa								+
Alonella sp.		+						
Aloninae		+				+		
Biapertura affinis	+	+					+	
B. longiqua								+
B. setigera								+
Chydorus sp.	+	+		+	+	+	+	+
Daphnidae								
Ceriodaphnia sp. (cf. dubia)	+	+						
Moinidae								
Moina cf. micrura		+						
M. cf. tenuicornis		+						
Ostracoda								
cf. Stenocypris		+					+	
indet. juvenile							+	
Site	R	C	E	B	L	J	D	Z
N taxa in sample	**17**	**32**	**5**	**4**	**4**	**18**	**11**	**14**

was dominant in Buffalo Reservoir, co-occurring with the cyclopoid genera *Eucyclops* and *Metacyclops*. In Lake Catani the plankton was numerically dominated by a suite of cyclopoids (*Meta-*, *Micro-* and *Tropocyclops*), which were likely to be preying on rotifers, thereby accounting for the low diversity of rotifers in the lake at the time.

Cladocera also were depauperate, and notably were all small species, with Chydoridae the best represented. *Chydorus* sp. was the most common, occurring in all but one site (Eurobin Creek). This taxon is small and globular, and tolerant of a wide range of conditions. *Alonella*

excisa (Fig. 3a) was found among the *Sphagnum* beds of Lake Catani. Exuviae of this species also were in Frey net sweeps through *Sphagnum* on the margin of Buffalo Reservoir. *Sphagnum* creates a low pH (3.7–4.9) in the local environment as its metabolism liberates acids. In Europe *A. excisa* is classed as an acidobiontic species and has its maximum abundance occurring at pH lower than 5.0 (Krause-Dellin and Steinburg 1986). The other two species recorded in 1998, *Alona guttata* and *Biapertura affinis* (Fig. 3b), are both tolerant of a wide range of physico-chemical conditions. Notably, two taxa of chydorids (*B. longiqua* and *B. setigera*), present in the Lake Catani 1997 sample, were not recorded in the 1998 sample. Their absence implies successional events in the chydorid community. It is likely that the number of chydorid taxa (and cladocerans generally) found at all Buffalo sites will increase in the future with preferential sampling of their littoral and benthic areas, especially in different seasons.

Ostracods generally are benthic in habit, hence probably were undersampled by our collecting methods. It is likely that more species remain to be identified in the Mount Buffalo region.

Biodiversity

In terms of overall communities, Lake Catani, with 32 microfaunal taxa identified, had the highest diversity, followed by Running Jump Creek (18 spp.), Buffalo Reservoir (17 spp.), Dingo Dell (11 spp.), Eurobin Creek (5 spp.), Lyrebird Plain and Crystal Brook (4 spp. each). A single *Sphagnum* sample from Lake Catani, April 1997 (14 spp.) is included in Table 1 for comparison. All sites are compared by cluster analysis (Statistica 1994) in Fig. 5, which ranks sites of increasing dissimilarity from left to right. That is, Lake Catani, with the most diverse microfaunal assemblage in 1998, shares some pelagic species with Buffalo Reservoir, e.g., species of the chydorid genera *Alona, Biapertura* and *Chydorus*, and the cladoceran *Bosmina meridionalis*, which also was collected from Lake Catani by B.V. Timms in 1973 (Smirnov and Timms 1983). Only two sites shared more than half their species - Lyrebird Plain and Crystal Brook, reflecting the low diversity at each site. Interestingly, the microfaunal assemblage least similar to that of Lake Catani in January 1998 is the Lake Catani *Sphagnum* sample from April 1997; only three testates, one rotifer and one chydorid occurred on both dates. Temporal dissimilarity in the microfauna of the same site is greater in this case than between sites on the same date, further indication of successional events and suggestive of microfaunal diversity yet to be recorded.

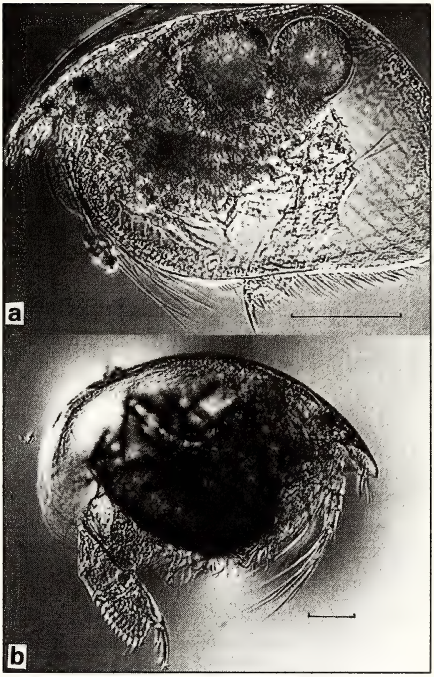

Fig. 3. Chydorid cladocerans, a. *Alonella excisa*, b. *Biapertura affinis*. Both from Lake Catani. Scale bars = 100μm.

Reasons for intra- and intersite heterogeneity of microfaunal assemblages in southeast Australia were detailed by Boon *et al.* (1990) and Shiel (1990). Suffice to note here, there is a direct correlation between microfaunal community diversity and the degree of habitat partitioning, for example by morphologically finely divided submergent vegetation such as *Myriophyllum*. Conversely, there is a strong negative correlation between microfaunal community richness and increasing flow - still waters are more likely to harbour a diverse microbiota than are flowing waters.

Conclusions

Our limited sampling precludes more detailed comparisons, yet it is apparent there is a diverse microfauna in the waters

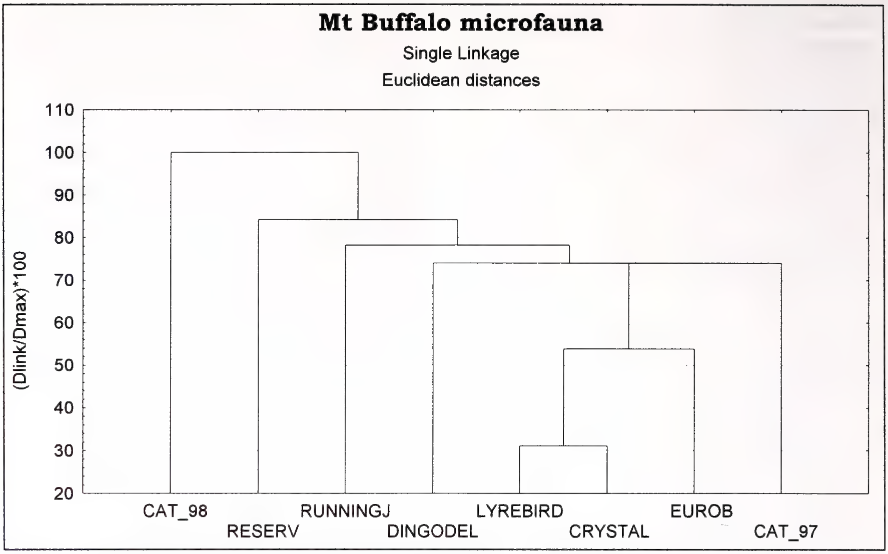

Fig. 4. Single linkage cluster dendrogram of microfaunal assemblages from Mount Buffalo sites. Sites are identified in the text.

of the Mount Buffalo National Park, albeit depauperate in comparison to that of billabongs at lower altitudes. The harshness of alpine winters may be significant in this respect. These few samples also provided evidence of complex interactions at the microfaunal level, an aspect of the ecology of Australia's inland waters which has largely been ignored. The aquatic microfauna of most Australian inland waters is poorly documented, particularly in terms of biodiversity. It would be difficult, if not impossible, to compile a comprehensive checklist of the microscopic animals inhabiting any body of water on the continent. Some of the reasons for this neglect were discussed by Green and Shiel (1992), and include poor taxonomic resolution of the microbiota, research concentration on the macrofauna, distance of most inland waters from research facilities, among others. Those inland waters which have received most research attention in recent years are those in which symptoms of eutrophication, salinisation and so on have become profound. Unfortunately, we remain ignorant of the more pristine aquatic environments in our national parks.

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First Records of Testate Amoebae (Protozoa: Rhizopoda) from Mount Buffalo National Park, Victoria: Preliminary Notes

Ralf Meisterfeld[1] and Lor-wai Tan[2]

Abstract

Eighty-nine species and subspecies were identified from eight habitats surveyed in an expedition to Mount Buffalo, Victoria in the winter of 1997. Of these, six have a strict Gondwanan distribution and 34 were new records for Australia. Highest species richness occurred in the wet *Sphagnum* habitat of Lake Catani where 50 species and subspecies were recorded. In contrast, the lowest species numbers were in the Dry Moss (16 species) and Humus Layer (15 species) at Mount Dunn. The relatively high diversity of testate species from Mount Buffalo may be the result of both the diverse nature of the substrates sampled, and sampling of an environment that has not experienced much anthropogenic activity. (*The Victorian Naturalist* **115** (5), 1998, 231-238).

Introduction

Testate amoebae are a group of single celled eucaryotic* organisms found in soil, marine and freshwater systems (Bonnet 1964; Cash and Hopkinson 1905; Foissner 1987; Golemansky 1978; Green 1975; Ogden and Hedley 1980; Schönborn 1962a; Shiel 1976). They differ in appearance from naked amoebae by their ability to build tests or shells (Fig. 1). Consistent appearance of the members of each species strongly suggests the method of shell construction is genetically inherent and species specific. The choice of building materials ranges from minute particles of sand (Fig. 2), diatom frustules* to biosynthetic* and organic material (Figs. 3, 4 and 5) (Ogden and Hedley 1980). Shell morphometry encompasses a range of lengths, depths and aperture diameters which can vary from ten to a few hundred micrometers (µm).

Ecology of testate amoebae

Semi-aquatic species present in *Sphagnum* moss and peatland of North America and Europe are a relatively well studied group of testate amoebae (Beyens and Chardez 1997; Heal 1964; Meisterfeld 1979; Schönborn 1962b). More recent studies on the relative importance of various environmental parameters which influence distribution patterns of sphagnicolous testates have confirmed previous observations that testate diversity and abundance in *Sphagnum* moss and soils is strongly linked to micro-environmental conditions with the degree of moisture the major limiting factor (Charman and Warner 1992; Tolonen *et al.* 1994). Vertical zonation by some testate species may also be attributed to the degree of light penetration.

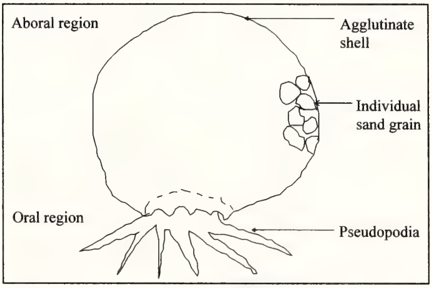

Fig. 1. Schematic representation of a 'typical' testate amoeba.

Fig. 2. *Lesquereusia modesta.* A lobose species common in the sediments of Lake Catani and in the wettest *Sphagnum* samples. The shell of the specimen is almost completely covered with mineral particles but morphs with a mixture of mineral particles and endogenous idiosomes (forma *mixta*) were also present in the material.

* see glossary at the end of this paper.

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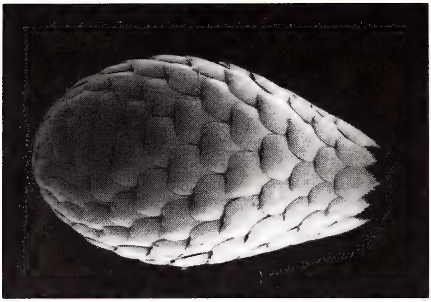

Fig. 3. *Euglypha australica* (spineless form). This species was described by Playfair (1918) as having a circle of long posteriorly projecting spines. In the organic sediments of Lake Catani a previously unreported spineless form was found. This form can be easily distinguished from the common, cosmopolitan *E. tuberculata* by its characteristic body-plates which are recessed both front and back, with a central, projecting spike in each plate. The anterior spike is always covered by plates and can only be observed by optical microscopy. This specimen is approximately 90 µm long.

Fig. 4. *Playfairina caudata.* An extremely rare species but quite common in the wettest *Sphagnum* samples. The aboral protuberance is of variable length but rarely as long as in the original description (Playfair 1918). The higher resolution of the SEM shows its test material is not simply organic as supposed by Playfair but composed of small siliceous plates.

Species such as *Heleopera sphagni,* which possess symbiont zoochlorellae*, are restricted to the green living portion of the *Sphagnum* layer (Heal 1962; Meisterfeld 1977, 1978, 1979; Schönborn 1962c).

Moss-soil microecotones play an important role in testate distribution patterns, with distinct boundaries detected between these two areas (Balik 1996). Schönborn (1967, 1989) constructed a habitat index of decreasing water content from: i) aquatic algal aufwuchs (biofilm), ii) *Sphagnum,*

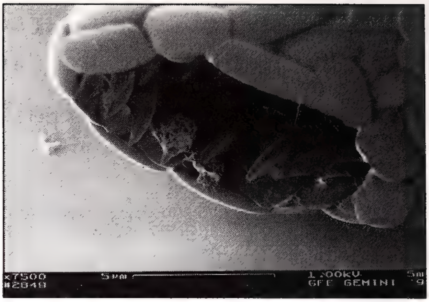

Fig. 5. *Playfairina caudata* (apertural view). The aperture is not invaginated as in the genus *Trinema.* The inner wall of the aperture is surrounded by a set of denticular and almost rectangularly shaped plates. The long teeth are curved inwards towards the aperture and may be interpreted as a defense structure against predators attempting to enter the shell.

iii) mosses (Bryidae), iv) sediments, and v) soils. He proposed that Testacea inhabiting the primary biotype (algal aufwuchs) had preadaptive genetically coded features which allowed them to colonize other habitats (secondary biotypes) in the series. He reported the genus *Centropyxis* as 'the most phylogenetically changeable' of testate amoebae with species found in the submerged aufwuchs on emergent plants as flat, wedge-shaped membranous and spined whilst those on submerged plants near sediments were high shelled species with short or absent spines.

Other environmental variables affecting testate population distributions include pH, dissolved organic carbon, carbon:nitrogen ratio of the peat, sample depth, nitrogen concentration in the peat and calcium concentration of the water (Charman and Warner 1992; Tolonen *et al.* 1994).

Materials and Methods

Taxonomy of testate amoebae

Taxonomy of testate amoebae is based primarily on gross morphological features unique to individual species. Light microscopy is used routinely for identification to species level but lacks the optical resolution for examination of test ultrastructure. This has been overcome by the use of scanning and transmission electron microscopy where, on occasion, species-specific ultrastructure details otherwise obscured can be examined. These include the presence of unique biosynthetic

interstitial organic cement patterns and cytoplasmic organelles* which represent significant improvements in identification of mainly agglutinate species (Hedley and Ogden 1973; Ogden 1983, 1987;Ogden and Ellison 1988; Ogden and Meisterfeld 1989).

Sampling sites

Eight sites were surveyed and are listed as follows:

i) algal mats and organic sediment at Lake Catani;
ii) Lake Catani sediment;
iii) moist-to-wet *Sphagnum* from the banks of Lake Catani (moisture classes III-IV as per Meisterfeld 1977);
iv) dry *Sphagnum* from Lake Catani (moisture classes V-VI);
v) aquatic vegetation from trail pools between Cathedral Rock and ski lift;
vi) humus layer directly beneath eucalypt (Mount Dunn);
vii) humus layer under grass cover (Mount Dunn) and
viii) dry moss on rocks (Mount Dunn).

Three samples from each site were collected in self-sealing plastic bags, kept at a constant temperature of 18°C, later transferred to screw-capped 10 ml plastic centrifuge tubes and preserved in 10% formalin.

Methods of analyses

Multivariate techniques were used to compare assemblages between sampling sites. These comparisons for all species were carried out using hierarchical agglomerative clustering (CLUSTER) of Bray-Curtis similarity measures on presence/absence data (PRIMER: Clarke 1993).

Results

A total of 89 species and subspecies were identified from Mount Buffalo (Table 1). Of these, 54 were in the subclass Testacealobosia with the remaining 35 members of the subclass Testatacefilosia (Table 1). (As this is only a preliminary report, several species have yet to be fully described.) There were also 34 new records for Australia consisting of members from 21 genera. Six species from five genera with strict Gondwanan distributions were also identified.

Habitat species richness

The four Lake Catani sites recorded higher species numbers compared with the three sites at Mount Dunn (Table 2). The moist-to-wet *Sphagnum* Lake Catani site had the highest species richness (Table 2). Fifty species were identified from this site, with an approximately equal number of species from each subclass. The next two most species rich sites were the pools in the Cathedral Rock area and algal mat/ organic sediment Lake Catani sites (33 species each), but were dissimilar in species composition (Tables 1 and 2). The fourth sediment Lake Catani site had only 24 species present, and that of the dry *Sphagnum* Lake Catani site (20 species) recording a significantly lower richness.

Mount Dunn sites generally had lower species richness (Table 2). Of the three sites sampled, the humus layer (eucalypt tree) site was the most diverse with 17 species. Both humus under grass (15 species) and dry moss (16 species) sites consisted of twice as many members in the Testacealobosia than Testaceafilosia subclasses. The rare *Corythion constricta* was identified from the otherwise species poor dry moss site; a first for Australia and only the fourth record since being described in 1888.

Species Composition

A comparison of species composition similarities showed two distinct site clusters (Fig. 6). The first cluster of habitats consisted of four sites: algal mats/organic sediment (Lake Catani), moist-to-wet *Sphagnum* (Lake Catani), sediments (Lake Catani) and trail pools. The second distinct cluster of habitats were: humus layer (eucalypt tree), dry *Sphagnum* (Lake Catani), humus (Mount Dunn) and dry moss (Mount Dunn) sites. The Bray-Curtis percentage similarity in species composition for each cluster was approximately 43.0%.

A few species such as *Corythion dubium, Trinema enchelys* and *T. lineare* were present in almost all eight sites sampled, their highest abundance being in the *Sphagnum* dominated habitats. There were also species with habitat specific distributions e.g. sediments characteristically had *Arcella catinus, A. megastoma alta, Argynnia* sp., *Difflugia lacustris, Lagenodifflugia vas, Nebela barbata psilonota, Pseudodifflugia microstoma* and *Euglypha australica* (Fig. 3). The humus sites had *Bullinularia* sp. and characteristic soil species such as *Plagiopyxis* sp. (Bonnet 1988).

Table 1. Presence/absence table of testate amoebae species vs. site identified from Mount Buffalo, winter 1997. Key: **i)** algal mats and organic sediment L Catani; **ii)** L Catani sediment; iii) moist-to-wet Sphagnum L Catani; **iv)** dry Sphagnum L Catani; **v)** aquatic vegetation from trail pools; **vi)** humus layer beneath eucalyp tree Mount Dunn; **vii)** humus layer-under-grass cover Mount Dunn, and **viii)** dry moss Mount Dunn. # =New records for Australia.

	i	ii	iii	iv	v	vi	vii	viii
Testacealobosia								
Suborder Acellina								
Microchlamys patella (Claparède and Lachmann 1859)#		+			+			
Arcella arenaria Greeff 1866		+	+		+			+
A. catinus Penard 1890					+			
A. hemisphaerica Perty 1852			+					
A. rotundata stenostoma Deflandre 1928			+					
A. vulgaris depressa Playfair 1918	+	+	+					
A. megastoma alta Playfair 1918					+			
Suborder Difflugina								
Apodera vas Certes 1888	+	+	+	+	+			
Argynnia antarctica (Grospietsch 1971)#			+					
A. dentistoma Penard 1890			+					
Bullinularia sp.#						+		
Centropyxis aculeata (Ehrenberg 1832)	+	+	+		+			
C. aerophila Deflandre 1929#						+		+
C. constricta (Ehrenberg 1841)			+		+			
C. deflandriana Bonnet 1959#				+			+	
C. elongata (Penard 1890)#							+	
C. ecornis (Ehrenberg 1841)		+	+					
C. plagiostoma Thomas and Bonnet 1955#						+		
C. sphagnicola Deflandre 1929 var.#	+			+				+
C. sylvatica Deflandre 1929#				+	+		+	+
Certesella certesi (Penard 1911)				+				
Cyclopyxis kahli Deflandre 1929#							+	+
C. kahli (form with small aperture)#					+	+		
Difflugia acuminata Ehrenberg 1832					+			
D. globulosa Dujardin 1837		+	+		+			
D. gramen Penard 1902 var.	+							
D. lacustris Penard 1890#	+				+			
D. linearis Penard 1890#								
D. lucida Penard 1890	+			+				+
D. penardi Penard 1890		+			+			
Hyalosphenia subflava Cash and Hopkinson 1909			+					
Heleopera rosea Penard 1890#			+					
H. sylvatica Penard 1890	+		+					+
Lagenodifflugia vas (Leidy 1874)#		+						
Lesquereusia modesta (mixta) Rhumbler 1895		+	+					
Nebela barbata psilonota Jung 1942#	+							
N. lageniformis Penard 1890	+	+	+		+			
N. penardiana Deflandre 1936#			+					
N. speciosa Deflandre 1936#			+					
N. tubulata Brown 1911		+	+	+	+			
Netzelia oviformis (Cash and Hopkinson 1909)					+			
Plagiopyxis callida Penard 1910							+	
P. declivis Bonnet and Thomas 1955#						+		
P. intermedia Bonnet 1959							+	
P. labiata Penard 1911#							+	+
Quadrulella symmetrica (Wallich 1863)	+		+	+	+			
Q. symmetrica longicollis Taranek 1882	+							
Trigonopyxis arcula (Leidy 1879)				+		+	+	
Zivkovicia compressa (Carter 1864)			+					
Suborder Phryganellina								
Cryptodifflugia sacculus Penard 1902#	+		+					
Phryganella acropodia (Hertwig and Lesser 1874)	+		+					+
P. acropodia depressa Playfair 1918								
P. acropodia penardi Decloitre 1955		+		+		+	+	+
Testaceafilosia								
Pseudodifflugia microstoma Playfair 1918#	+							

Table 1. (Continued).

	i	ii	iii	iv	v	vi	vii	viii
Order Euglyphida								
Assulina muscorum Greeff 1888	+	+	+	+		+		
Corythion constricta (Certes 1888)[#]								+
C. dubium Taranek 1882	+	+	+	+	+	+	+	+
C. dubium (slender form)			+	+				
C. dubium aerophila Decloitre 1950[#]		+			+	+		
Edaphonobiotus campascoides Schönborn, Foissner and Meisterfeld 1983[#]	+		+					
Euglypha acanthophora (Ehrenberg 1843)	+				+			
E. anodonta Bonnet 1960[#]			+					
E. australica Playfair 1918	+				+			
E. australica (spineless form)	+							
E. ciliata (Ehrenberg 1849)					+	+	+	+
E. compressa Carter 1864	+	+		+		+		
E. compressa glabra Cash, Wailes and Hopkinson 1915 var.			+					
E. cristata Leidy 1874		+	+		+			
E. filifera Penard 1890	+		+					
E. rotunda Wailes and Penard 1911	+		+	+	+		+	
E. laevis Perty 1849			+					
E. strigosa (Ehrenberg 1972)		+	+	+	+	+		+
E. strigosa heterospina (Penard 1890)[#]			+		+			
Placocista ventricosa Thomas and Gauthier-Lièvre 1959 (spineless form)[#]		+	+		+			
Playfairina caudata (Playfair 1918)	+		+					
P. valkanovi Golemansky 1966[#]			+		+			
Sphenoderia fissirostris Penard 1890			+		+			
S. lenta Schlumberger 1845[#]	+		+		+			
S. splendida Playfair 1918			+	+				
Tracheleuglypha dentata (Vejdovsky 1882)	+	+	+		+			
Trachelocorythion pulchellum (Penard 1890)[#]			+					
Trinema complanatum Penard 1890	+		+	+		+	+	+
T. enchelys (Ehrenberg 1838)	+	+	+	+	+	+	+	
T. galeata Penard 1890[#]			+			+		
T. grandis Chardez 1960[#]	+		+					
T. lineare Penard 1890	+	+	+	+	+	+	+	+
Valkanovia delicatula (Valkanov 1962)[#]	+	+	+	+				

Table 2. Total number of testate amoebae species and their corresponding species richness recorded from each of the eight sampling sites. Key: A, Total number of species; B, Species richness (Shannon diversity index) (H').

Sites	A	B
Organic sediment (L Catani)	33	9.15
Sediment (L Catani)	24	7.24
Wet Sphagnum (L Catani)	50	12.5
Dry Sphagum (L Catani)	22	6.79
Rock pools	33	9.15
Humus/Eucalypt tree (Mt Dunn)	17	5.65
Humus/grass(Mt Dunn)	15	5.17
Dry moss (Mt Dunn)	16	5.41

Numerically dominant species in all *Sphagnum* samples were the small euglyphid species such as *Corythion,* small *Euglypha* and *Trinema. Playfairina caudata,* although a rare species since its description by Playfair (1918), was common in some of the wetter samples (Figs. 4 and 5). The wettest habitats in this series were characterized by an aquatic complement of several *Arcella* species, *Centropyxis aculeata, C. ecornis, Difflugia globulosa, Zivkovicia compressa, Lagenodifflugia vas* and *Lesquereusia modesta* (Fig. 2).

The minerotrophic nature of these *Sphagnum* habitats was reflected by the presence of *Argynnia dentistoma* and *Quadrulella symmetrica,* which are absent in true rainwater fed ombrotrophic bogs (Meisterfeld 1979).

Discussion

We report here for the first time 34 new species records for Australia from Mount Buffalo, Victoria, inclusive in a species list totalling 89 members. The diversity of

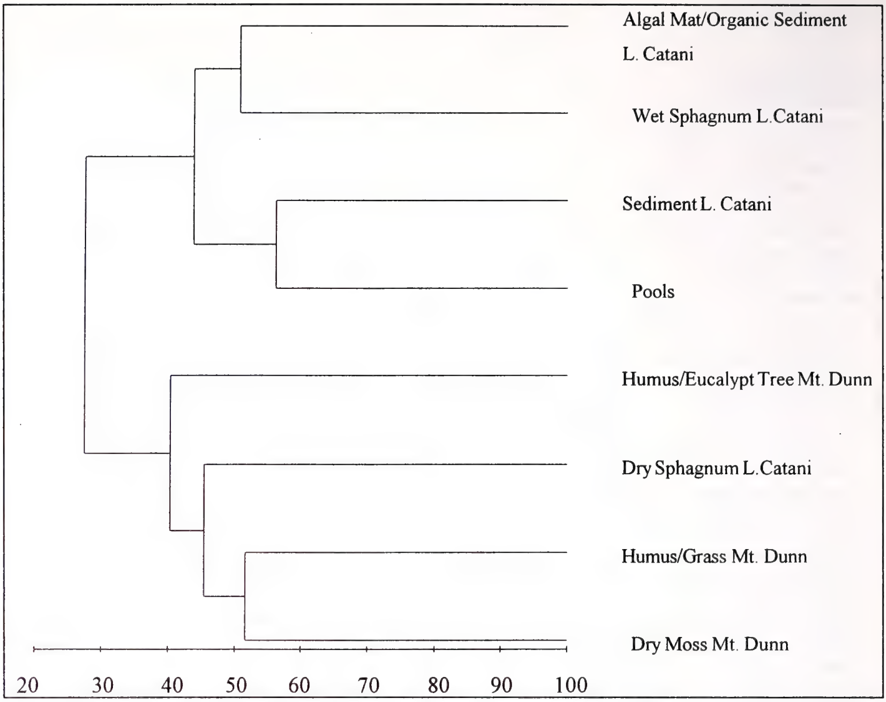

Fig. 6. Dendogram for hierarchical clustering (using group-average linking) of the eight sampling sites based on the Bray-Curtis similarity matrix using presence/absence data.

species recorded is comparable to Playfair's (1918) survey. His comprehensive list (122 testate species recorded and described) is a reflection of the habitat types sampled, i.e. weed and *Sphagnum* beds in or near ponds, creeks and rivers. However, in other Australian studies, only 12 (Gilles 1915) to 15 species (Whitelegge 1891) were recorded. Their low species numbers may be explained by i) many of the species found in this survey then had not been described; ii) lack of specialist testate taxonomists to aid with identifications, and iii) the habitats surveyed were primarily of the lowland and coastal plains of Brisbane, Queensland and outskirts of metropolitan Sydney, New South Wales. The high species diversity at Mount Buffalo may be representative of the Alpine environment which provides favourable and variable enough growth conditions to support a diverse testate community.

There were significant variations in species distribution across all eight sampling sites. Species richness was proportionally higher in habitats with either a high moisture content, or principally, in aquatic sites. Within the Lake Catani sampling area, the wet *Sphagnum* site recorded the highest number of species. Sites showed that a reduction in species numbers corresponded to a decrease in water/moisture content. Overall lower species numbers in the Mount Dunn sites appeared to be correlated with the lack of *Sphagnum* habitats.

Species richness is influenced in part by microecotones, the edge effect between *Sphagnum* conditions (semiaquatic and acidic) and the littoral zone of the shallow Lake Catani. Fluctuations in the watertable throughout the year would facilitate the exchange of species between these two habitats.

Our list did not include species (with the symbiotic zoochlorellae*) which characteristically inhabit the upper green portions of *Sphagnum* as found in Eurasia and North America (Schönborn 1962c; Meisterfeld 1977, 1979). This may be due to local physico-chemical factors such as extremes in seasonal variation affecting *Sphagnum* water content, testate colonizing history of

the relatively small and young *Sphagnum* patches, or that these species generally are not commonly members of Rhizopod fauna in the Australian Alps. Of this group, only *Heleopera sphagni* (Eumundi, Queensland) and *Amphitrema stenostoma* (Blue Mountains, New South Wales) have been reported from Australia (Penard 1911). More studies on the *Sphagnum* dominated biotopes need to be conducted to determine factors influencing distribution patterns of these species.

Predatory species were represented in our samples by a cosmopolitan complement of *Nebela lageniformis, N. penardiana, N. speciosa, N. tubulata* and included a group with Gondwanan distributions (*Apodera vas, Certesella certesi* and *N. barbata psilonota).* In this group, *A. vas* was especially common in all aquatic and *Sphagnum* habitats. Other common and dominant *Nebela* species of European moss communities like *N. collaris, N. militaris* and *N. tincta* were absent from our material.

Although *Sphagnum* habitats generally have a more diverse testate amoebae community than the adjacent humus (Schönborn 1962b), the very low species numbers in our samples could not be accounted for. In undisturbed forest soils in Europe, it is usual to find between 25 to 50 species per sample and even higher numbers ranging from 77 taxa in the Philippines and 150 in Nepal (Bonnet 1977, 1980).

Conclusion

This preliminary study has proved encouraging in terms of uncovering a large and diverse testate community at Mount Buffalo National Park, Victoria. The role of testate amoebae as bio-indicators of environmental conditions has yet to be fully explored. Monitoring changes in testate community composition may well be a suitable method for ascertaining the effects of physico-chemical perturbations on alpine ecosystems and thus deserves our greater attention.

Glossary

Biosynthesis - Formation of organic compounds by living organisms.

Cytoplasmic organelle - Structure within an eucaryotic cell in which certain functions and processes are localised.

Diatom frustules - Thin shells of silica associated with a group of algae in the Bacillariophyceae class.

Eucaryote - Organisms with cells possessing a membrane-bound nucleus containing DNA. ***Eucaryotic cells*** have an extensive cytoskeleton and membrane-bound organelles such as mitochondria.

Zoochlorellae - Symbiotic green algae living in cells of various animals.

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Pond Life on Mount Buffalo, FNCV Camp-out 1903/04

In the immediate vicinity of the camp was a creek, running down a rugged gully, which on the first days of our visit was a chain of small waterholes, and an investigation resulted in the capture of some crustacean forms regarding which Mr O.A. Sayce reports as follows:-

'The bottle of specimens collected by you from a creek at 'Haunted Gorge', on the summit of Mount Buffalo, contained two species of sessile-eyed crustaceans. One is an Isopod, *Phreatoicus australis*, Chilton, and belongs to a family of considerable morphological and physiological interest, so far known only in Australasia. Until now it has been recorded only from the top of Mount Kosciusko, NSW, and Mount Wellington and Lake Petrach, Tasmania. In the bottle were two females, each with developing young in the marsupium, and also a number of free very young forms. The other is an Amphipod, closely related to the genus *Niphargus* of the old world, where the various species are blind inhabitants of subterranean waters. On close inspection I failed to find any important differences from *Neoniphargus fultoni*, Sayce, collected from an altitude of 3,000 feet near Wood's Point, except that all of the present specimens are devoid of eyes...'

J. Shephard, *The Victorian Naturalist* **20**, 1904, 151.

Observations of Heliozoans in Ice-covered Ponds on Mount Buffalo

Kirill Mikrjukov[1] and Roger Croome[2]

Abstract

Microscopical observations of plankton collected from four ice-covered ponds on the plateau area of Mount Buffalo in July/August 1997 revealed six taxa of freshwater heliozoa and one heliozoan-like amoeba. Three of the organisms - *Ciliophrys infusionum*, *Actinophrys sol* and *Polyplacocystis coerulea* - had been observed previously from Australia, but four - *Chlamydaster sterni*, *Elaeorhanis cincta*, *Choanacystis rhytidos* and *Heterophrys marina* - were recorded for the first time on the Australian continent. The presence of all seven species below ice belies the assertion (based largely on experimental rather than field observations) that heliozoa exist in an encysted form during winter.

(*The Victorian Naturalist* **115** (5), 1998, 239-241).

Introduction

Some 100 species of heliozoans have been reported world-wide. Traditionally known as the 'sun animalcules', these single-celled organisms radiate long axopods which are used for both feeding and locomotion. Sexual processes are rarely observed. The taxonomy is based on gross morphology and, for some taxa, electron microscopical examination of siliceous scales covering the body. For a descriptive overview of the Heliozoa see Febvre-Chevalier (1990).

Up until 1997, 22 genera of heliozoans and heliozoan-like amoebae had been reported from Australia (eg. Croome 1986, 1987a,b; Mikrjukov and Patterson 1998) from a range of aquatic environments, living either as part of the plankton, or at the sediment-water interface where they use their long axopods to capture prey.

Observations at Mount Buffalo

An international workshop on freshwater protozoa was held at Albury in July/August 1997. Collecting trips in support of the workshop were made to local rivers and streams, floodplain billabongs, and Mount Buffalo. At Mount Buffalo, four small ice-covered ponds (three were approximately 1 km south-east of Tatra Inn, and one about 200 m along The Gorge Road to The Chalet) were sampled on 30 July and 1 August 1997 using a hand-held plankton net. Water temperatures were 2.8–4.3 °C, pH values 5.1–6.0, and electrical conductivity values less than 15μSiemen cm^{-1}. The samples were examined in Albury by light microscopy within 3–6 hours of collection. Living heliozoa were measured and drawn, and those with skeleton-bearing cells were formalin-fixed and air-dried, to be gold-palladium coated and viewed using scanning electron microscopy at the Moscow State University.

Six heliozoan taxa were observed from the Mount Buffalo ponds, three for the first time in Australia, while an observation of a heliozoan-like amoeba *Elaeorhanis cincta* was another first record for Australia.

Ciliophrys infusionum Cienkowski 1876

Two relatively large specimens were observed (15–20 μm in diameter), each with a single flagellum. *Ciliophrys infusionum* has a worldwide distribution (Siemensma 1991) from both fresh and marine waters. It was probably recorded from Australia by Schewiakoff (1893) as *C. australis* (Croome and Mikrjukov 1998), and has been recorded in Western Australia by Patterson and Simpson (1996) (Fig. 1).

Actinophrys sol Ehrenberg 1830

A few small (<15 μm) specimens were observed. The best known and most widespread heliozoan, previously reported from Australia on numerous occasions (Mikrjukov and Patterson 1998)(Fig. 2).

Chlamydaster sterni Rainer 1968

Very abundant in the samples, but differing from the type material in size, being only 4–5 μm in diameter cf. 10–12 μm in the type. Cells surrounded by a smooth homogeneous coat 0.8–1.0 μm thick. The Mount Buffalo observation was the first record of *Chlamydaster* in Australia (Croome and Mikrjukov 1988) (Fig. 3).

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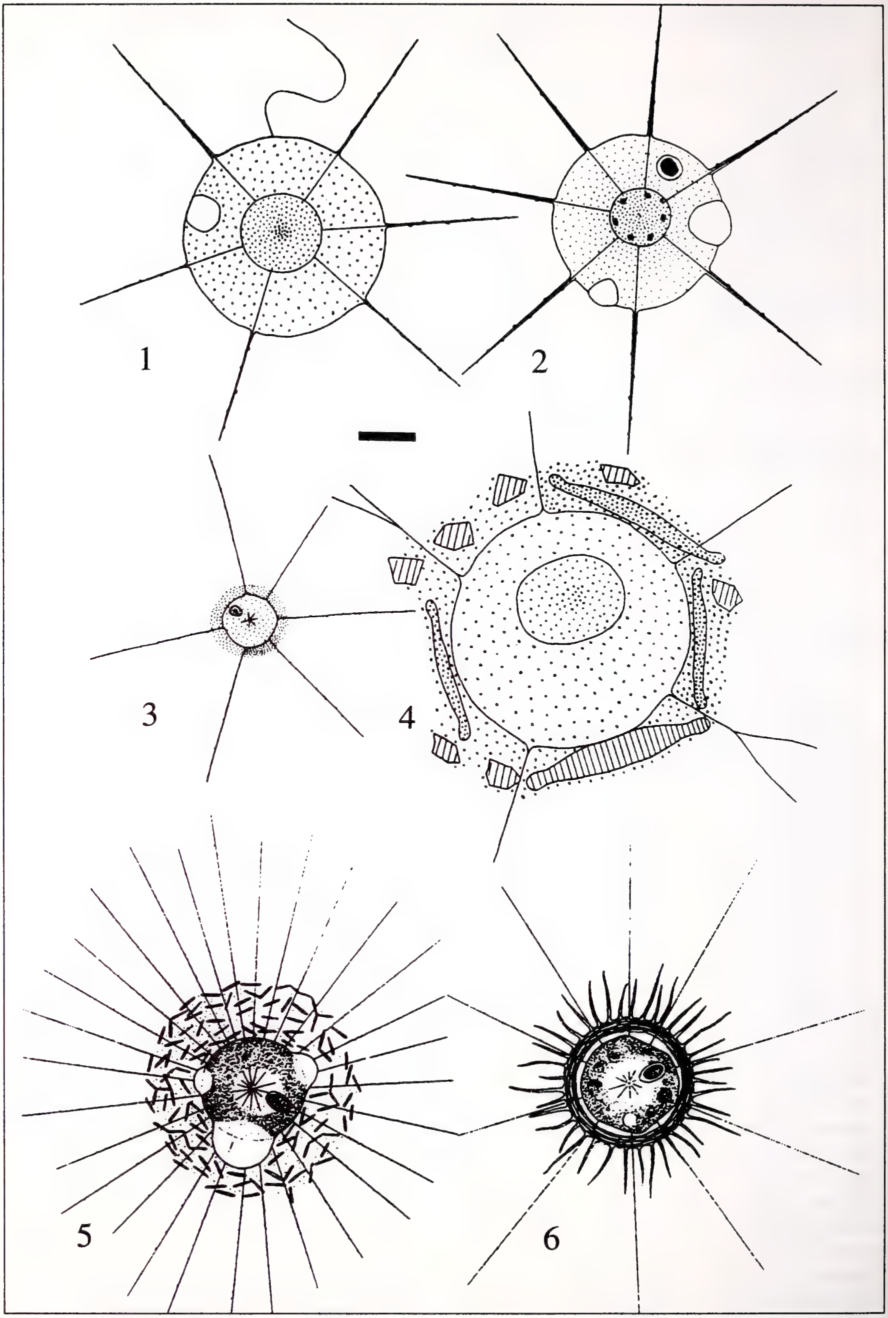

Figs. 1-4. Drawings of Mount Buffalo material. Scale bar denotes 5μm.
Figs. 5-6 Illustrative drawings from Siemensma (1991).
Fig. 1 *Ciliophrys infusionum*. **Fig. 2** *Actinophrys sol*. **Fig. 3** *Chlamydaster sterni*. **Fig. 4** *Elaeorhanis cincta*. **Fig. 5**. *Polyplacocystis* sp. **Fig. 6** *Choanocystis* sp.

***Elaeorhanis cincta* Greef 1875**

Two specimens, 18–20μm in diameter, were observed. The mucous cell sheath contained numerous small sand grains and several diatom shells. *Elaeorhanis cincta* (Fig. 4) is referred to rarely, and was reported previously only from central Europe and Argentina. While its true taxonomic position is currently uncertain, we believe it should be located within the nucleariid amoebae (Croome and Mikrjukov 1998).

***Polyplacocystis coerulea* (Penard 1904) Mikrjukov and Patterson 1998**

Very abundant in the samples, and relatively large at 20–27 μm in diameter. A widespread species, *P. coerulea* has been observed only once before in Australia, in Queensland by Mikrjukov and Patterson (1988)(see Fig. 5).

***Choanocystis rhytidos* (Dürrschmidt 1987) Siemensma 1991**

A single specimen 12 μm in diameter was observed, being much smaller than the type (35–40 μm). The Mount Buffalo observation of *C. rhytidos* is the first for Australia. This species has a limited distribution, being recorded previously from Chile, Sri Lanka and New Zealand (Dürrschmidt 1985, 1987)(see Fig. 6).

***Heterophrys marina* Hertwig & Lesser 1874**

Only one organism was observed, 12 μm in diameter, with a mucous sheath which gave rise to numerous radial organic spicules. Of widespread occurrence in both marine and fresh waters, *H. marina* was possibly observed from Australian fresh waters by Whitelegge (1891). For light micrographs and drawings of *Heterophrys* see Rainer (1968) and Patterson (1992).

Comment

In addition to establishing the existence of three additional heliozoan taxa in Australia, and one heliozoan-like amoeba, the above observations demonstrate the presence of a considerable heliozoan fauna in an active state in ice-covered ponds on Mount Buffalo, belying the assertion that heliozoa exist in an encysted form during winter (eg. see Rainer 1968). While observations of encystment have been made in several heliozoan taxa, they have all been under experimental rather than field conditions (see Croome and Mikrjukov 1998) and no evidence of encystment was observed during examination of the Mount Buffalo samples. It is interesting to note that many of the organisms observed were 2–3 times smaller than expected, and it is hoped that observations at other times of the year will give more complete information on life cycles with respect to changes in size, feeding patterns, and state of encystment.

Acknowledgements

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The History and Natural History of Mount Buffalo in Pictures

Michael McBain[1]

Mount Buffalo was recognised soon after its 'discovery' by Hume and Hovell to be a spectacular natural feature (Fig. 1).

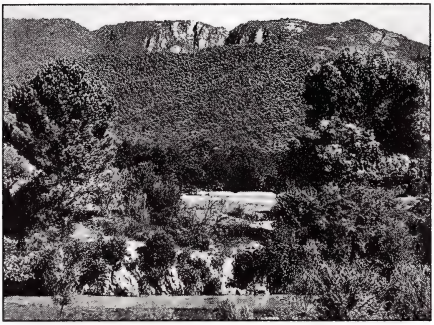

Fig. 1. View of Mount Buffalo from Porepunka. From Dunn (1908), ill. 1.

Grazing was only finally phased out in the 1950s. But visits by field naturalists at the turn of the century showed that Buffalo had a great deal more to offer than grazing, and pressure from the Bright Alpine Club resulted in the first reservations in 1898 of what became Mount Buffalo National Park. Contemporary pictures are a valuable resource for those who would like to understand how the natural and human landscapes of an area have changed over time. In the case of Mount Buffalo, there is a rich pictorial resource available to the keen student of the landscape. Such resources can often show features of places we know, but which have changed imperceptibly over time. For land managers trying to restore some semblance of an original landscape, such pictures are invaluable.

The State Library of Victoria has a substantial collection of images which is available over the internet. The Rose Stereograph Company was very active throughout Victoria, and George Rose took many hundreds of photographs from the turn of the century. The company is still in business and their postcards (black-and-white, and coloured) are still on sale at the Mount Buffalo Chalet. A visit to any regional art gallery is almost certain to turn up a painting of Mount Buffalo, and there must be numerous unrecorded vintage photographs taken by families who have visited this spectacular natural treasure over the past 100 years.

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Natural features

The granite landscape of the plateau and slopes provided inspiration for many artists and photographers. Flora Gregson painted a watercolour of Mount Buffalo from the Ovens Valley in 1907 (the original is in the State Library of Victoria), and numerous other artists have certainly done so since.

Government geologists James Stirling and E.J. Dunn both made excursions to the plateau. Dunn's report was extensively illustrated with photographs of the spectacular tors and rock outcrops (Dunn n.d.). It is interesting to compare the scenes in Dunn's photographs with the present day. For example, Fig. 2 shows the Gorge about 1890, Fig. 3 the same spot about 1980. The scene has changed little, except for a somewhat thicker shrub layer in the creekbed, and perhaps a few more trees in the later photograph. It was in this area that Monkey Mint-bush *Prostanthera walteri* (now *P. monticola*) was discovered. The Horn in Dunn's day had a small cairn perched atop (Fig. 4), whereas today the peak is particularly obvious when viewed from the east because zinc leaching from the safety rail has killed all the lichens and left a bright cream-coloured area (this can just be seen,

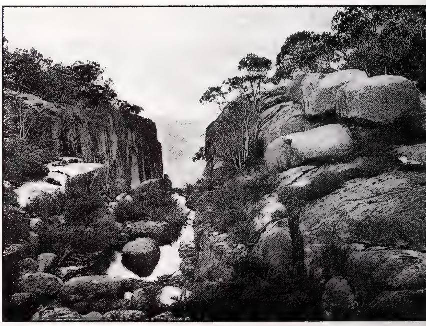

Fig. 2. View of the Gorge. From Dunn (1908), ill 3.

Back Cover).

The Mines Department took an enormous number of pictures at Buffalo, often giving the locations picturesque names. The Gorge was known as the Northcote Crevasse, and who of our readers today knows where the Shuffle of Bells, Big Ben, the Bridge of Sighs, the Leaning Tower or the Chinese Mandarin are to be found?

Two major projects were the building of the Reservoir, to provide water for the Chalet, and the damming of the Long Plain to form Lake Catani. Figure 5 shows the Long Plain in its original form, about 1890, and Back Cover the present Lake Catani. This small lake was formed about 1908 by damming the outflow of the Long Plain. Both provide an interesting comparison with the present day.

Tourism, huts and the Chalet

The early visitors to the plateau, such as Barnard and Sutton (1903), endured considerable hardship to reach the top, and also while staying there. Camping was the norm at the turn of the century for the field naturalists. Even so, presumably anticipating a tourist boom, enterprising locals set up accommodation. Of these, Carlile's Hospice was located at what is now Hospice Plain (Fig. 6). In 1899, the Manfields set up a similar establishment, the 'Alpine Lodge', on the north side of The Gorge, not far from the present-day Manfield's Lookout.

In 1890, the Mines Department prepared drawings for a proposed 'mountain hotel' at Mount Buffalo. This was a 'boom' time in Victoria, and certainly the plans were in what is now known as the Boom style. It

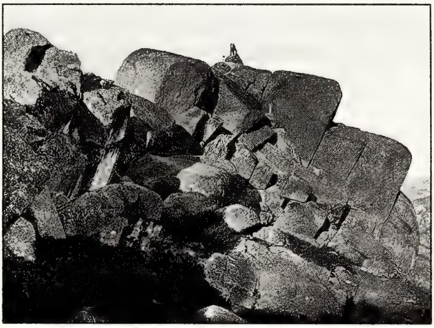

Fig. 4. The Horn. From Dunn (1908), ill.5.

Fig. 5. Long Plain before being flooded to form Lake Catani. From Dunn (1908), ill. 4.

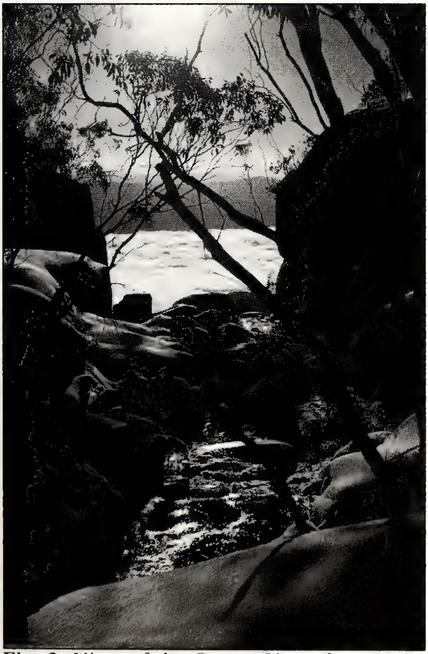

Fig. 3. View of the Gorge. Photo from Parks Victoria, Mount Buffalo Collection.

Fig. 6. Carlile's Hospice. Historic slide from NRE, Historic collection.

was to be an extremely grand affair, resembling a small European castle. It is hard to believe it now, but the Victorian Railways Department was once a major force in the development of tourism in Victoria, establishing numerous major establishments throughout the State, in particular at Mount Buffalo and the Grampians. With the opening of the Chalet around 1908, the small operators were soon forced out of business, although not without considerable complaint. Since the concept of competitive neutrality was at least ninety years in the future, their cries fell on deaf ears, although minimal compensation was paid.

The Chalet, when finally built, was a far more modest affair than the Mines Department had planned, and was originally much smaller than the present-day spreading establishment (Fig. 7). There are numerous photographs at the State Library showing its development, including some aerial shots.

Skiing in Victoria developed at the Chalet, principally because it was almost the only accommodation above the snowline before World War II, and because of an early European influence (Johnson 1974) (Fig. 8). George Rose took many photographs of 'skiing' lessons, resulting in a series of amusing postcards.

Fig. 7. Mount Buffalo Chalet in the 1920s. Photo from Parks Victoria, Mount Buffalo Collection.

Fig. 8. Skiers travelling to the snow by sled in the 1930s. Photo from Parks Victoria, Mount Buffalo Collection.

Flora and fauna

There are several endemic plant species at Mount Buffalo, but the only one to make it onto the face of a stamp is a variety of Mount Buffalo Sunray *Leucochrysum albicans*. In 1986, Australia Post issued a stamp with an illustration of the species by Betty Conabere (Fig. 9). There is also a stamp illustrating The Horn. This was a 50 cent stamp issued in 1973.

Fig. 9. Mount Buffalo Sunray *Leucochrysum albicans*. Australia Post 25 cent stamp issued in 1986

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Mount Buffalo National Park: An Historical Perspective

Peter Jacobs[1]

Abstract

This year Mount Buffalo celebrates 100 years as a national park. The park has always had significant visitor pressure dating back to the 1850s when the first tourist parties arrived. Rustic huts built for the first tourists were replaced by chalets and ski resorts and a subsequent boom in recreational activity. Today, Mount Buffalo is one of Victoria's finest national parks, balancing high tourist visitation with protection of a unique environment. (*The Victorian Naturalist* **115** (5), 1998, 245-254).

Introduction

Mount Buffalo was first set aside as a site for a national park in 1898, in the same year that Wilsons Promontory received a similar status. These parks are Victoria's oldest existing national parks and celebrate their centenary this year. The pressure for park reservation and early management of the park was largely driven by tourism, commercial and recreation interests, which makes for a fascinating and colourful history reflecting the variety of political and social life in Victoria throughout the twentieth century. Mount Buffalo, the legacy of those early protagonists, is now one of Victoria's, and indeed Australia's, icon national parks.

Aboriginal history

Aboriginal people once occupied the high country and its surrounding valleys and plains. Tribes such as the Jaitmathang, Dudoroa, and Minjumbuta are known to have visited the high country in summer, in association with the annual migration of Bogong Moths (Slattery 1998). Bogong Moths breed on the hot plains of northern New South Wales and southern Queensland, and with the advent of warmer conditions, the moths fly south to seek respite in the cooler high country, gathering in rock crevices usually above 1500 m. Aborigines ate the moths for their high protein and fat content. Many tribes are known to have met on the Murray River near present-day Albury (Mungabareena) before receiving permission from the occupying tribes to proceed to the high country of Victoria in summer. This also offered an opportunity for celebration and socialisation.

However, at Mount Buffalo, it is believed that only the Minjumbuta tribe visited – the Echidna people – a solitary tribe that did not share its area with others (Kneebone *pers.comm.* 1996).

After thousands of years of occupation, Aborigines fared poorly when white people arrived in the area. The two cultures clashed and conflict was inevitable. Whites were hungry for land and its resources, and there was no recognition of previous occupation. The aborigines tried to defend their tribal areas from the invaders, but disease and massacre took its toll. Few survived more than a few decades after whites arrived.

Early exploration, mining and settlement

In 1824, Hume and Hovell, whilst on an expedition from Sydney to Corio Bay, named the site Mount Buffalo because they thought that it resembled a giant, sleeping Buffalo.

Two years later, Mitchell (surveyor general) passed through the Murray district, and his report of excellent grazing land brought a flood of squatters. He reportedly named The Horn, Mount Aberdeen. In 1845, the squatter, Buckland, took up Junction Run near Porepunkah, the first grazing licence in the area, and Thomas Goldie, his manager, took up residence 10 miles into the Buckland Valley. In the 1850s and 1860s, families with the names of Manfield, Weston, Brady and Carlile started to settle the area and played a key role in the future of Mount Buffalo.

Meanwhile, gold was discovered by Purdoe in the Buckland Valley in late 1853, causing a major rush. By 1854, over 5 000 miners were on the Buckland goldfields, at the foot of Mount Buffalo.

Renowned artist Nicholas Chevalier visited the area in the late 1850's returning

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in 1864 to paint Mount Buffalo from One Mile Creek, near Porepunkah. He entered the painting in an art competition run by the National Gallery (Melbourne) for the best picture by a local artist. 'The Buffalo Ranges' can still be viewed at the Gallery.

First visits

Thomas Goldie, who stayed in the area following Buckland's brief occupation in 1845, along with several other local settlers, used the Goldie's Spur route to bring cattle up on to the Mount Buffalo plateau (Weston 1986).

On 26 February 1853, Ferdinand Mueller (later Baron von Mueller), recently appointed Government Botanist, and John Dallachy, Superintendent of Melbourne Botanic Garden, climbed the Horn, and stayed on the plateau until 4 March. They were on an expedition to collect alpine plants for the Botanic Garden (Waters 1967). Mueller was probably led there by Buckland (Weston 1986) and their visit was the first recorded ascent of The Horn, although it is likely that Goldie and others had preceded them (Weston 1986). It is also interesting to note that Mueller made no mention of the presence of either cattle or other settlers such as Buckland.

Mueller and Dallachy named and collected several new plants such as: Royal Grevillea *Grevillea victoriae*, after Queen Victoria; Yellow Kunzea *Kunzea muelleri*, after Mueller himself, and *Acacia dallachiana*, after John Dallachy. Mueller was a tireless collector and explorer in his own right, and his efforts ensured Victoria's high mountain flora was reasonably well-documented very early in the colony's history (Gillbank 1992).

The following year, settlers James Samuel and brother John climbed Buffalo via the Goldie's Spur track and spent several days exploring (Waters 1967). No doubt they became known for their knowledge of the mountain, and in 1856, James led a party of miners to The Horn and Gorge. This was claimed to be both the first tourist party for those seeking to see the beauty of the area and an expedition to seek new areas for mining (Webb and Adams 1998; Wilkinson 1929). Although there was no gold on the mount, James Manfield claimed the right to be the first guide (Wilkinson 1929). Thus began a career for both himself and his family in guiding on Mount Buffalo.

The 'birth of tourism'

In 1873, Bill Weston climbed to Mount Buffalo, pioneering a rough route from the north side and by 1874 passengers could travel by train to Wangaratta, and Mount Buffalo was now coming within reach. In 1875, Bill Weston led a group of doctors from Melbourne, who wished to holiday in the area, to the plateau via his new route. They were so enchanted that it became an annual event. He constructed a log cabin for them in January 1879, which was the first recorded building on the plateau and sometimes referred to as the 'Doctor's Hut' (Weston 1986). The hut was burnt down in the 1939 fires and replaced with the current stone picnic shelter in 1940.

The second hut built on the Mount was a temporary affair, commissioned by member for Ovens, Mr. Smith of Beechworth, for a trip he organised in 1886 which included Victorian Governor Loch. He was trying to promote the plateau as a tourist destination (Allom *et al.* 1986). Thomas Goldie built the hut from oil paper and hessian and it was located near the bottom of the current Cresta ski lift. Unfortunately, the Governor fell ill and never made it to the hut (Weston 1986).

In 1887, an article in the *Bright Alpine Observer* strongly opposed the anticipated alienation of part of the Buffalo plateau into pastoral blocks and stated that 'Buffalo was destined to become a popular holiday resort for metropolitan tourists. Furthermore this government would be of further dereliction of its responsibilities if it allowed another natural feature of interest to pass out of the hands of the State'.

In the same year, a Dr J.F. Wilkinson came to practice in Bright. His desire to promote the tourist potential of the area was strong and he discussed the issue with other like-minded people including Mr W.A. Staker, a commercial traveller and frequent visitor to the mount, Rev .W.L. Fenton, the local Presbyterian minister, Mr. Harry Smith, bank manager, and Shire Secretary, Mr. Chauncey. They formed a committee and thus inaugurated the Bright Tourist Club and Promotion Committee, later known as the Bright Alpine Club, which was to promote devel-

opment of the district as a tourist resort (Wilkinson 1929). Staker was president and at the inaugural meeting, they urged the reservation of sites at Mount Buffalo, Hotham and other places (Bardwell 1974). They also levied businesses to build tracks and promote the area.

In the publication 'Illustrated Guide to the Victorian Alps: Buffalo Ranges' it states that 'the tourist should spend two or more days on the summit camping out. The complete isolation from the world of business, the exhilaration of the wildness and magnificence of the surroundings brings the tourist in close sympathy with nature' (Bright Alpine Club 1887). Bardwell (1974) suggested that their promotion of mountaineering, fresh air and vigorous exercise was unique at the time and could be interpreted as a precursor to wilderness philosophy. In 1888 a letter was sent to the Secretary for Lands from the Club requesting that certain land at Mount Buffalo be reserved as a public park, naming The Horn, The Hump and The Falls in the application. At this time there was no formal action (Department of Crown Lands and Survey, rs File 121), but the Club continued to be busy raising funds and promoting the area. Wilkinson encouraged a local resident and cattleman, Carlile, to build a hospice to accommodate people on the mountain. It was opened in December 1891 and was built under the rights of a miner's claim, catering mainly for summer guests. It had a bathroom and toilet and fully-licensed bar (see Fig., p).

In addition, in 1890, James Manfield built the Temperance Hotel, later known as Buffalo House, at the foot of the Gorge. It advertised that visitors would be met at Porepunkah Station and driven to the Hotel. From there, the Manfields would guide people up Stakers track with camping gear to camp on the plateau (Hoy 1965).

The beginnings of a National Park

Meanwhile, pressure for a park was growing. Since the letter to the Secretary for Lands (in 1888) seeking a reserve on Mount Buffalo, increased activity around Eurobin Falls was of concern to the Bright Shire. Miners were taking timber for the mines at Chiltern and Rutherglen, and visitors were removing shrubs and ferns for gardens. The roads were being torn up by timber traffic which made it difficult for tourists. The Shire Secretary and Alpine Club Secretary again wrote to the Secretary of Lands seeking a reserve to protect this 'far flung beauty spot' (Department of Crown Lands and Survey, rs File 121). The Minister took it more seriously this time and sought comment.

The Conservator of Forests, George Perrin supported the national park proposal. However, John Wallace MP angrily put forward concerns that the land was needed to cut lathes for mines and wanted the reserve stopped. Mining interests referred to 'such nonsensical purpose as a public park' (Department of Crown Lands and Survey, rs File 121). The wishes of the Bright Alpine Club prevailed and on 31 October 1898, 2880 acres were reserved as a site for a national park and gazetted on 4 November 1898.

Manfields move up the mountain

The Manfields realised that tented camps were no match for Carlile's new Hospice. Like Carlile, James Manfield Jnr, son of J.S. Manfield also took out a miners right under the belief that he too had the right to erect a house for accommodation. He subsequently built a house overlooking the Gorge, probably in 1899, commonly known as the Alpine Lodge. The park declaration in 1898, however, specifically excluded such occupations under miner's right, but Carlile, having constructed his hospice prior to the park declaration felt he was excluded from that condition (Department of Crown Lands and Survey, rs File 121). A storm erupted. Lyndon Smith as secretary of the Bright Alpine Club, wrote to the Secretary for Lands bringing his attention to Manfield's actions and Carlile wrote to local member Isaac Isaacs complaining of the unfair competition. The Bailiff warned James Manfield Jr. that if he did not remove the structure, proceedings would be taken against him (Department of Crown Lands and Survey, rs File 121). Manfield then wrote back to the Minister claiming ignorance of the law, but maintaining that he had a duty to look after tourists. He presented a petition of support for himself signed by nearly one hundred residents of the Ovens Valley, which was presented to Parliament.

The outcome was that both James

Manfield Jnr. and Carlile were granted a licence under Section 99 of the *Land Act* 1890 to occupy three acres each at their respective sites, but with no long-term commitment and no compensation when they were asked to leave (Department of Crown Lands and Survey, rs File 121).

Another more substantial cottage was then built on Manfield's three-acre entitlement. Alice Manfield tells of when she and her brother Bill built a new cabin on a site near Bents Lookout in 1902 (Hoy 1965) (Fig. 1)

More development

The need for a better road soon became obvious. Following a deputation sent by Bright Shire to Melbourne seeking financial assistance for a road to Buffalo and other nearby alpine attractions, local MLA Alf Billson demanded, in Parliament, immediate action to improve roads leading to Victoria's mountain resort (Webb and Adams 1998). In a glowing description of the plateau given in 1907 by E J Dunn after his geological survey, he called it the 'Garden of the Gods'. This induced Sir John Mackey, Minister of Lands, to visit. He was so impressed he convinced the Premier, Sir Thomas Bent, to provide money for a new road. It was opened by the Premier on 9 October 1908 and generally followed the route of the original Stakers track.

In his speech, the Premier expressed his intention of continuing the Government's policy of opening up the State's tourist spots to tourism (Allom *et al.* 1986). The Premier must have been greatly impressed as he also proceeded to extend the land for a national park to 23 100 acres, gazetted on 14 October 1908, and announced that a new solid stone chalet overlooking the Gorge was to be built by the Government.

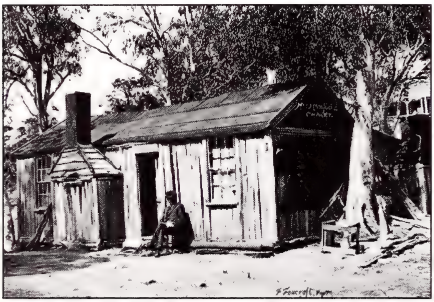

Fig. 1. Manfields Chalet, built 1902, demolished 1910. Note new Chalet in background. Photo from Parks Victoria, Mount Buffalo Collection.

Regulations for the Care, Protection and Management of the National Park were gazetted on 25 November 1908 under section 199 of the *Land Act* for the '*Good order and decency therein and for the collection of tolls, entrance charges and other charges for entering therein or thereupon*' (Department of Crown Lands and Survey, rs File 121).

The Premier's stone chalet did not eventuate and the public works department instead proposed a cheaper wooden structure. A lake on the plateau was considered essential for fire protection and to drive machinery, so in 1908 a contract was let to dam Eurobin Creek along Long Plain (Webb and Adams 1998).

After many delays and with the costs blown out from £4000 to £7000, The Chalet was completed and leased privately to John Newton. It opened in July 1910; however, poor roof design made habitation difficult, with most guests leaving disgusted. It was no Hilton; with a lack of lining, leaking roofs, and broken windows most guests came to meals wearing coats and rugs, and then moved smartly to the fireplace (Waters 1967).

The beginning of a monopoly

The government attempted to close Carlile's Hospice and Manfield's Chalet to eliminate competition on the Plateau.

In 1909, Carlile wrote to the Minister for Public Works seeking compensation for lost trade as a result of the decision to build the Chalet. Carlile died in 1913 and three years later his wife accepted a Lands Department offer of £575 to surrender the Hospice and it was demolished in 1917. The Government then gazetted regulations to prevent any further occupation by way of a miner's right in areas reserved for a national park (Allom *et al.* 1986).

The Manfields were given orders to vacate their site in 1910. The site was cleared and Jane Manfield was paid £50 compensation. There was a public outcry, however, and in October 1910 the *Alpine Observer* printed a 'plea for justice for the Manfields', also mentioning injustices done to Carlile. The writer asked was it fair that people who did so much to

encourage visitors to Mount Buffalo should now become victims of a Government monopoly (Webb and Adams 1998). Eventually the strength of public opinion forced a compromise. The government granted the Manfields two sites on the other side of the Gorge, one for Bill Manfield on which he built his new Alpine Lodge near Reed's Lookout (Fig. 2), and the other for Alice and her mother Jane, on which they replaced Manfield's Chalet with Manfield's Bungalow (Fig. 3). Manfield's Bungalow stayed in the family until it was destroyed by fire in 1930. Manfield's Alpine Lodge took guests until 1930. It remained as a residence and refreshment room. Manfield was instructed by the committee of management to remove it in 1935, and it was demolished two months later and moved to Bright (Committee of Management Minutes). The Chalet now had the park to itself.

Fig. 2. The Alpine Lodge. Photo from Parks Victoria, Mount Buffalo Collection.

Fig. 3. The Bungalow. Photo from Parks Victoria, Mount Buffalo Collection.

First rangers and a committee of management

Following a report from Chief District forester, Maurice Griffin, of unsupervised grazing activity earlier that year (Department of Crown Lands and Survey, rs File 121). Mr. Jock McKinnon, overseeing road works for the Public Works Department, was appointed a bailiff in September 1909 to collect agistment, and camping fees and hire tents. Bill Weston was the bailiff from 1912-1922 and C Wilcox was appointed to help him in 1915 (Department of Crown Lands and Survey, rs File 121). Mr. Edmiston is recorded as being a ranger in residence in 1921.

A Management Committee was formed by the Board of Land and Works in 1918 to manage the Park under section 184 of the *Land Act* 1915. The original committee comprised Joseph Reed (Secretary of Lands), Alexander Lang (Forests), Augustus Peverill (Under Secretary of Lands) and William Keast (Victorian Railways). The committee in the early days mainly dealt with issues over management of the road. These issues were complex, with the government tendering rights for commercial carriage of visitors, battles between horse-drawn carriages and motor cars, and the need to regulate up and down traffic due to the narrow nature of the road. Bailiffs seemed to spend most of the time staffing the gates along the road.

The grazing era

Buckland probably introduced cattle to the plateau in 1847, reaching the area from the south along Goldie's Spur. Soon, other graziers from the Buckland Valley followed (Weston 1986), and Westons, Hughes, Carliles and Brady started bringing up cattle from the north side after the first track was constructed from that side in 1888. They were still grazing cattle when the Chalet was built in 1910. Chalet management complained about stock fouling drinking water supplies (Webb and Adams 1998). Grazing ceased in 1923 following railways Commissioner, Harold Clapp's intervention (Weston 1986).

It was clear, however, that the management Committee supported 'controlled grazing'. Grazing was reintroduced in 1938 and continued sporadically as the committee believed it was necessary for fire prevention and 'illegal grazing was impossible to control so it may as well be licensed'. The Field Naturalists Club of Victoria complained to the Committee about the resumption of a grazing licence in 1939 (Stewart 1942). In 1942, *The Victorian Naturalist* published an article written by H.C.E. Stewart titled 'Botanical Paradise or Cattle Run?', complaining about the impact that cattle grazing and fires lit by cattleman were having on Mount Buffalo (Stewart 1942). They later sent a deputation to the Minister for Lands, Bill Everard, but still failed to convince the Committee that the grazing licences should be cancelled.

In 1950, the FNCV again attacked the government over the deplorable damage caused by cattle at Mount Buffalo National Park. Pressure again mounted and another deputation was sent to the Minister for Lands, Sir Albert Lind. The committee was put under more pressure, but still resisted. Finally, the last grazing licence fee was collected in 1956, but there is no evidence that grazing was ever officially terminated by the committee. It seems likely that the new National Parks Authority, formed in 1956, may have influenced the Committee not to reissue licences.

Victorian Railways come on the scene

Harold Clapp was Chairman of the Victorian Railways in 1920 and took a keen interest in tourism. He was influenced by his time spent with the North American railways and knowledge of resorts at Banff and Yosemite where railways ran hotels in or near parks at the end of the line. He took interest in Mount Buffalo, knowing it was fed by his railways and that the Railways would benefit from every passenger carried to The Chalet. Sight unseen, he convinced the government to allow the railways to take the lease over in 1924 from the current lessee, Hilda Samsing. There was no public call for tenders.

The Chalet was then run by the Railways Refreshment Service and a major improvement program was promptly undertaken when it was realised what a poor state the Chalet was in. Despite improvements the Chalet rarely recorded a profit and was criticised as an exclusive hideaway for wealthy Victorians and a resort for elderly invalids (Webb and Adams 1998).

The recreation era

It was a response to some of these criticisms that both the Committee of Management and Chalet Management saw the need to offer opportunities to take part in adventure activities on the plateau. Mount Buffalo was heavily promoted by the Victorian Railways for mountain scenery, horse riding and snow sports.

Guide Alice Manfield had entertained guests on walks since the 1890s through to the 1920s, and horseriding became established. The Chalet was hiring out ice skates for skating on Lake Catani, and in 1918, Cathedral and Horn Huts were in place so that skiers and walkers could gain access to the more remote areas of the park (Committee of Management Minutes). Fred and Ernie Chalwell were two locals adept at outdoor sports, and were employed at the Chalet to take horse trips across the plateau, and introduce people to winter sports such as ice skating, skiing and tobogganing. In 1930, Mr. Bert Keown, the Superintendent of the Railways Refreshment Services was given full responsibility for the development of Mount Buffalo as a snow resort and summer hiking and horse riding paradise (Webb and Adams 1998). He was also railways representative on the Committee of Management.

The 1930s were a busy time for the Committee of Management, endeavoring to improve facilities for visitors. Huts were upgraded and new tracks were surveyed and built. Lookouts and signage were improved. During the depression, 'Susso' gangs were employed to work on roads, completing The Horn Road in 1933.

Despite the flurry of activity, minutes of the committee note in 1935 that Government is not sympathetic to making money available for tourist work. It was noted in 1936 that the ranger's salary was £180 per annum. The ranger at the time was Harry Harrison, who lived in a ranger's house at Mackey's Lookout (Chick *pers. comm.* 1998) (Fig. 4).

The committee noted on several occasions in the late thirties their desire to keep the Park natural,

Fig. 4. The Rangers House *c* 1936 with Winn and 'Harry' Harrison on verandah. Photo from Parks Victoria, Mount Buffalo Collection.

'While endeavoring to cater for the public under winter conditions, in providing buildings, etc., the Committee has not lost sight of its desire of not civilising the plateau and would keep to the spirit of rough grandeur by encouraging the walker and tourist rather than making it a paradise for the motorist and having buildings as far as practicable conform to the natural surroundings and not despoiling the landscape. In keeping it in a state of nature as much as possible tracks rather than roads would be provided.'

This would appear to reinforce the vision of the Bright Alpine Club forty years earlier, and perhaps these words, noted in the minutes, were a result of concern over pressure for more development by the Railways. There was a 'desire to have buildings to conform with the rough nature of the country'. The excellent stone shelters built by the Committee at The Gorge, Campground (1940) and The Horn (1938), today are testimony to these sentiments.

This period also brought about a heightened interest in skiing on Mount Buffalo. In the early thirties, the railways department applied to clear some slopes for skiing at 'The Grand Skiing Grounds', Cresta. A tractor hauled skiers to slopes at Lakeslide, Cathedral and Cresta ski runs. Bert Keown, in an attempt to put Buffalo at the forefront of skiing destinations, enlisted Chalet engineers to construct a motorised ski tow at the foot of the Cresta Run. In his enthusiasm, Keown overlooked the need for the approval of the Management Committee. The tow opened in August 1937, and was the first motorised ski lift in Australia. It was extended the following year, but ceased to operate during World War II when fuel was scarce and could hardly be used to run a ski lift, a device for the privileged (Webb and Adams 1998). The first ski lift in Australia had short but sweet history.

Although the war made the forties a difficult time for commerce, Bert Keown continued to press for improved facilities and turned his sights to Dingo Dell. He convinced the management committee to allow him to clear slopes and erect skiers shelters and conveniences. Dingo Dell was opened in 1940 and a lift was installed under the direction of the management committee in 1949, but due to problems was not operational until 1951. The ranger was responsible for the lift's operation under the direction and authority of the management committee. Chalet employees continued to cut new tracks and improve others. Bert Keown was determined to ensure the Railways maintained presence and influence over Mount Buffalo, despite continual Chalet losses.

In 1948, the park was increased in size to 27 280 acres and formally gazetted a National Park, rather than a site for a National Park as it was previously known.

The post-war period began a resurgence of interest in skiing and increased competition between Victorian resorts (Peach 1976). From the mid 1940s to 1950s, skiing occupied most of the funds and labour of the committee (Committee of Management Minutes). The State Development Committee Report of 1950 recommended improving huts, roads and rail to the mountain and improved facilities at the main ski fields, identifying Cresta as a suitable site for a resort. As a result a new ski lodge was opened in 1954, at Dingo Dell, Keown Lodge. The committee then announced that future development in the Park should be concentrated on the Cresta Run (Committee of Management Minutes), presumably for those seeking more challenging ski runs, but little happened for ten years.

A National Parks Authority

In 1956 a *National Parks Act* was put in place for the management of National Parks, previously administered under the *Lands Act*. The new Act set up a National Parks Authority (NPA) charged with coordinating the management of parks across the state. Interestingly, an amendment in 1958 provided for areas in parks to be leased to private developers. The Committee of Managers at Buffalo, however, resented NPA personnel encroaching on its territory and it appears

they were quite uncooperative (Webb and Adams 1998).

The lack of knowledge at the time is also apparent by a note in the first Annual Report of the NPA in 1957 that 'wombats and wallabies are the only native mammals that are at all commonly seen, but a survey would probably reveal rarer species worthy of special protection' (Department of Crown Lands and Survey, rs File 121). The report also noted that at The Chalet, a staff of 80 or 90 provide accommodation for 184 guests! These high staff levels were probably welcomed by guests, but perhaps part of the reason the Chalet was unprofitable.

It also appears that the lack of proper construction of many tracks and the impact of numerous horses was starting to show. In 1964, the committee resolved that it was most dissatisfied with the poor and neglected condition of the Park as a whole and, unless rapid improvement was made, the Committee would have no option but to resort to drastic action.

Development at Cresta was slowly evident throughout the late fifties, with a proposal in 1960 to develop a small chalet designed for future expansion. It was resolved later that year that this would best be done by private authorities because of the expense (Committee of Management Minutes).

Resort development

In 1962 the NPA reported that the ski field facilities at Dingo Dell were poor and there were management problems with instructors and skiers. They also noted that the Cresta skifields were still largely ungroomed despite many years of discussion and effort. The NPA called for private development of the ski slopes, and the management committee were irate (Webb and Adams 1998). They were defensive of their past efforts and resented the NPA interfering. Nevertheless, the NPA proceeded with calling for expressions of interest.

A partnership of businessman Sir Rupert Clarke and former Chalet ski instructor, Ollie Polasek was successful in being awarded a lease of ten acres at Cresta to develop a resort. The proposed development was in three stages: accommodation, restaurant and ski lifts; a public lake and Egg Rock Hotel; sub lease for private condominiums.

Tatra Inn was completed in 1964, with a chairlift to service the slopes. The developer, Tatra Development P/L had its frustrations with the bureaucracy. Polasek said to the Management Committee that 'unless Tatra is excluded from the rules and regulations of the National Parks Authority and the area declared a holiday resort, we have no hope of succeeding and the development will be discontinued' (Committee of Management Minutes). A two-storey motel then followed with the Cresta poma and a T-bar.

The VNPA attacked the proposal for a lake in June 1967 and accused the NPA of blatant derogation of its duty under the Act if it were to allow the lake. In 1971 approval was given to construct the lake; however, a storm erupted in the press in 1972 with a flood of letters to the editor, mostly condemning the idea. The case put by Polasek was that the lake would be one of great beauty, and of historic interest. It was also for fire protection and for recreation, including skating, fishing and swimming (Polasek 1972). Meanwhile in a government report on the development of snow resorts in Victoria by D.G. Handley, it was recommended that the expansion of the Tatra lease not proceed.

In 1972, the government put a freeze on further development by the Tatra owners despite pressure that they be allowed to continue, and in 1975 Tatra Holiday and Ski Resort was purchased by the government for $987 000. With regard to the proposed expansion, The Minister, Mr Borthwick, said 'such a development is no longer in keeping with community wishes. It would seriously damage the natural environment' (Webb and Adams 1998).

The birth of the National Parks Service

Meanwhile, the Committee of Management were continuing to manage Dingo Dell, with a new pomalift opened in 1966. They were busy with tracks and facilities and it seems that they had little involvement in the Tatra development. A new *National Parks Act* was enacted in 1971, with the National Parks Service (NPS) replacing the National Parks Authority (NPA). Park management was becoming more complex, with more parks to manage and a need to centralise policy and management. Committees of Management

were replaced with a National Parks Advisory Committee in 1975. The Mount Buffalo National Park Committee of Management was disbanded after nearly 60 years of service to the Park.

The National Parks Service as resort managers

The newly formed National Parks Service took over management of the Park. With the resumption of the Tatra lease, the NPS quickly needed to put a management arrangement in place for Cresta Valley.

The NPS leased the motel, restaurant and ski school to private interests but all the outdoor operations were managed by the NPS. A large workforce was needed, and the NPS presence on the mountain climbed from two rangers to a Park Manager, Ranger-in-Charge, Resort Manager, several rangers, mechanics, fitters, carpenters, maintenance crew, accountants, administrative officers and all the support crew for the ski season such as ski patrollers, lift operators and fee collectors. A work-force of up to 60 was employed in the ski season.

Following previous years of indecision, the NPS had a clear direction. In a visionary article for *Ski* magazine (Ski 1978) the then NPS Director, Mr. John Brookes, was asked where Mount Buffalo would be in ten years, i.e. 1988. He said that the emphasis would be on family recreation, providing good skiing facilities at minimum cost to visitors; that development would be minimal and regulated to protect the environment for summer. He said that there would be no plans to increase accommodation on the mountain, but there were plans to upgrade day visitor facilities over the next three years. An entrance station was opened in 1979 to charge a park entry fee.

The resorts continued to demand most of the attention of park managers. The complex task of running a ski resort was time-consuming and expensive, and the lessee of Tatra Inn was not always totally satisfied with the standard of the outdoor operations, on which they relied for business.

The Tatra lessee left in 1988, but by this time the new Department of Conservation, Forests and Lands had absorbed the NPS and was considering whether it was really its core business to be running the operational aspects of a ski resort.

The busy seasons of the late seventies and early eighties were becoming a memory only. Once where there were 1200 cars and fifty buses on the mountain, a good day now was 300 cars and a dozen buses. Dingo Dell was once known as the best beginner area in the State, and the full carpark on weekends was proof of this fact. The larger ski resorts soon improved road access for buses and their facilities for novice and beginner skiers. Dingo Dell slowly lost the market niche.

The Land Conservation Council and final additions to the National Park

In 1980, the Government accepted the recommendations of the LCC, and the Park was extended to include most of the foothill country adjoining the plateau, to the Buckland, Ovens and Buffalo Rivers below. The park, now 31 000 ha, had new issues to deal with, such as pest plants and animals, and the interface with private land in the valleys.

The end of the Railways era

V-Line management at the Chalet had deteriorated and it was re-leased to a private company for $1 million and later taken over by Victorian Snow Resorts.

By the early nineties, the Government started to look at private involvement in what had previously been government business. In 1992, the whole operation at Cresta Valley was leased, but this lasted only one year. In 1993, the Chalet was privately leased. The Chalet lessee also took over the lease for the skifields at Cresta and Dingo Dell in the same year. The Chalet lease provided capital for building improvements and the new management's interest lay in nature-based ecotourism and heritage-style accommodation.

A new focus for Park Management

Resort management made it difficult for park managers to concentrate their time, effort and funds on total park management. In 1992 this changed. Staffing levels dropped to the core. The first Management Plan was to leave the management of the day-to-day resort operations to private interests, while parks staff maintained an important business relationship and partnership with the lessee.

All year round visitor numbers had been increasing but many of the facilities were

tired and worn out. Environmental and cultural site management lacked a strategic approach, mainly responding to issues as they came up.

Major capital works programs improved visitor facilities such as new interpretive signs around the major sites, including The Gorge, The Horn and Dickson's Falls. The Park entrance area was upgraded to improve the sense of arrival and provide quality pre-visit information and rangers developed environmental and cultural site management programs. Major pest plant eradication programs were put in place.

The centenary

1998 marks the centenary of the reservation of Mount Buffalo in 1898 as a site for a national park in the area around The Gorge and Eurobin Falls. It is an opportunity to reflect on 100 years of park management. Over this one hundred years, activity at Mount Buffalo has been frenetic, bureaucratic and a reflection of Victorian life in the twentieth century. At the end of the day, however, to the best of our knowledge, the park is in good condition and meets the high standard objectives of the *National Parks Act*.

Traditional park values of care and protection were instilled in the park's management from the start and the respect that people today have for the park has its roots in those traditional values. Potentially damaging activities, apart from grazing, were controlled and prohibited early in the life of the park. The park now receives 250 000 visitor days per year, but by good planning and perhaps the constraints of the environment, 95% of those visitors only physically visit 5% of the Park (Jacobs *pers. obs.*). Vast remote and natural areas still exist and receive, in many cases, fewer visitors than 50 years ago. The main visitor sites are well-adapted to accept that visitation and thanks to the foresight of the Committee of Management buildings are generally sympathetic to the outstanding natural landscape.

The one legacy of the past that still needs attention is the damage to tracks by horses during the decades that horses were promoted on the plateau. Limited riding is still permitted and the need for quality and expensive track repair work is ongoing.

Nevertheless, Mount Buffalo is close to the hearts of many Victorians and in a Statewide survey in 1997, Mount Buffalo National Park had the highest level of satisfaction in the community compared to all other major parks in the State (Yann *et al.* 1997). What a wonderful achievement in the build-up to the centenary! The centenary year itself is the largest promotional event ever seen in the park, and it is an opportunity to raise community awareness of the importance of national parks, and the place that Mount Buffalo holds on a world scale in the history of park management.

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The Mount Buffalo Story, 1898-1998

by Dan Webb and Bob Adams

Publisher: *The Miegunyah Press, Melbourne University Press, 1998. R.R.P. $39.95.*

This is both an attractive book, with evocative photographs on the cover and strategically placed throughout the text, and a very readable book.

It is pleasing to see a chapter each devoted to the geology and the Aboriginal way of life, myths and legends, that are so important to this area.

Characters who played important roles in the story of early European settlement, such as Tom Goldie the stockman, Ted Carlile who built Carlile's Hospice on the Plateau, James Manfield who built Granny's Place in the valley, and Alice Manfield, an early guide on Mount Buffalo, are all brought to life. Early visitors and flora collectors to 'the Garden of the Gods' also get a mention, such as John Monash, Ferdinand Mueller and the superintendent of the newly created Melbourne Botanic Garden, John Dallachy.

The first declaration of the Mount Buffalo National Park was signed on the 31 October 1898 and the wooden 'temporary' Government run Chalet was opened in 1910. Early tourists arrived by train at Bright, stayed overnight and were taken next morning by horse-drawn coach to the Chalet. All this, plus six nights' accommodation, for £4.10s, although guests often had to wear coats and dressing gowns to dinner because of the lack of heating. But snow sports were growing in popularity and tourism increased, as did complaints about the Chalet's poor management and threadbare furnishings. In 1993 the government leased the Chalet to a private company and within two years it had won the Victorian Tourism Award in the resorts category.

Controversies seemed to have plagued the area, beginning with rivalry and intrigues over the building of the early huts and hospices; the right to transport tourists and, perhaps closest to hearts of Field Naturalists Club of Victoria members, the battle between graziers and environmentalists over cattle grazing rights. It is this episode in which the FNCV was most vocal and most successful, beginning in 1940 with Archie Campbell and continued later by Ros Garnett, both of whom campaigned strongly for the removal of cattle because of the destruction they caused to the native flora. Then in the 1960s the developments in Cresta Valley which brought all conservation groups together in opposition, and became known as the 'Tatra episode' These stories are told sympathetically and in rich detail.

While the wheeling and dealing of individuals, groups and government are convincingly told, and the history of snow sports in Victoria is woven throughout, the authors never lose sight of their major focus, 'the Mountain'. The beautiful photographs of Mount Buffalo continually remind the reader of its presence. The authors end on a positive note that, judging from the new *Management Plan*, much has been learned from past mistakes and, in future, 'the kookaburras in the Garden of the Gods should be laughing'.

The research for this book is thorough, evidenced by the detailed endnotes. The Appendices are particularly informative, listing flora (vascular plants only) and birds of the area. Appendix 3, Place Names, supplies grid references and comments on the origin of the name or special occurrences at the particular place. A separate Bibliography would have capped off this section.

For those who have walked, camped, skied, spent a holiday or a honeymoon on Mount Buffalo, this book will bring back delightful memories and deepen their understanding of this magnificent National Park. For those who have not yet had the pleasure of exploring Mount Buffalo, this book will surely provide the impetus.

Kathleen Ralston
53 Horwood Drive, Breanlea, Victoria 3227.

The Field Naturalists Club of Victoria Inc.

Reg No A0033611X

Established 1880

In which is incorporated the Microscopical Society of Victoria

OBJECTIVES: ***To stimulate interest in natural history and to preserve and protect Australian flora and fauna.***

Membership is open to any person interested in natural history and includes beginners as well as experienced naturalists.

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The Editors thank all who contributed to this Mount Buffalo Centenary issue of the *The Victorian Naturalist*:

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Proof readers for their sharp eyes and useful comments
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Several authors and members have submitted extra photographs for our consideration - ***Sharon Ford, John Hawking***, and ***Peter Jacobs***, who sent down photos from the Mount Buffalo Collection.
Charles Leski for the postage stamps.
David Meagher for help with the map and ***Anne Morton*** for scanning the map and adapting it for our use.
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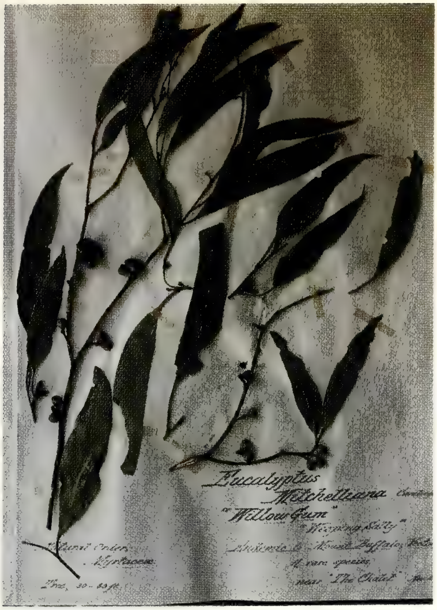
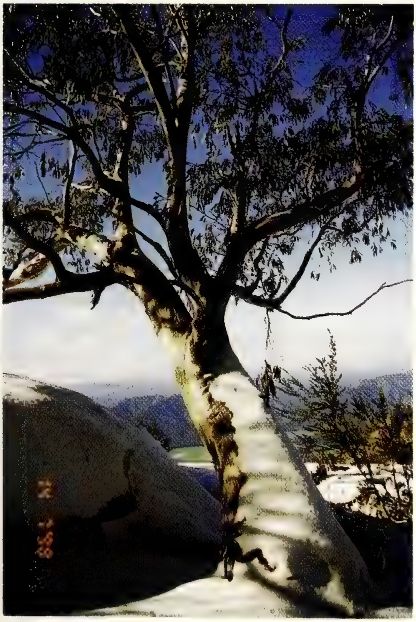
Address labels - ***Felicity Garde***.

And our printers, ***Brown Prior Anderson***, 5 Evans Street, Burwood, Victoria 3125, in particular, ***Steve Kitto***, who is always ready to help.

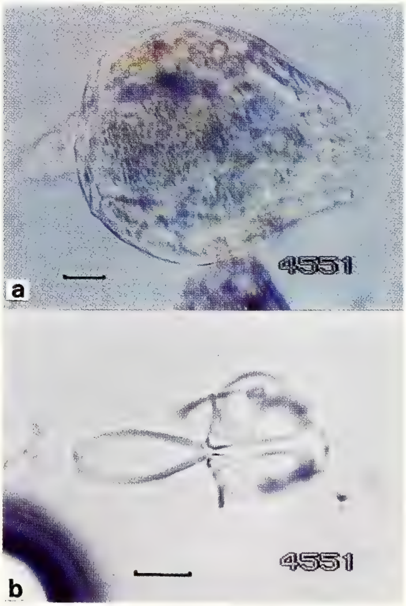


A. St. John's specimen of Buffalo Sallee *Eucalyptus mitchelliana*. Photo by Ron Fletcher.

B. Buffalo Sallee *Eucalyptus mitchelliana*, in 1998. Photo by Ron Fletcher.



C. Buffalo Sallee *Eucalyptus mitchelliana* growing near Wilkinsons Lookout. Photo by Allison Marion.



D. Rare rotifer, *Rousseletia corniculata*, a: habit, contracted; b. trophus (teeth) Scale bars=10 μm. (Sony video prints). Photo by Russel Shiel.

PLATE 4

A. Common Silver Xenica *Oreixenica lathoniella herceus* which flies at the same time as *O. latialis.* Photo by David Crosby.

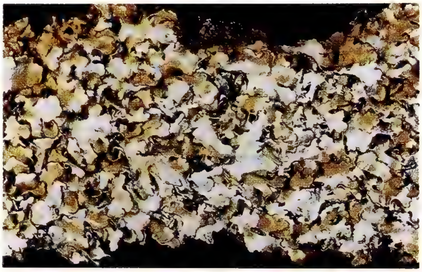
B. *Oreixenica latialis theddora,* a subspecies of the Browns endemic to Mount Buffalo. Photo by David Crosby.

C. *Canoparmelia corrugativa* (Kurok. & Filson) Elix & Hale, new record, Victoria. Photo by Sharon Ford.

D *Xanthoparmelia rupestris* Elix & J. Johnst., new record, Victoria. Photo by Sharon Ford.

E. *Xanthoparmelia suberadicata* (Abbayes) Hale, rare on rock in the cooler mountain areas of Victoria (Elix 1994). Photo by Sharon Ford.

F. *Cladonia staufferi* Abbayes, endemic; unique among Australian specimens of *Cladonia* in being confined to areas of regular snowfall. Photo by Sharon Ford.

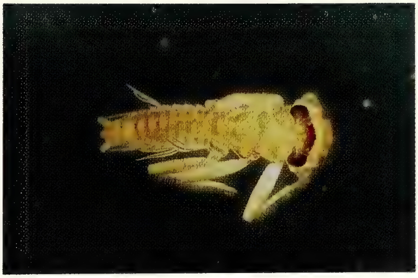


G. *Xanthoparmelia luminosa* (Elix) Hale. has a thick, glossy thallus with orange-pigmentation in the medulla (interior). Photo by Sharon Ford.

H. *Umbilicaria cylindrica* (L.) Delise, large specimen from the Horn, showing single point of attachment (umbilicus) in bottom right hand corner. Photo by Sharon Ford.

PLATE 5

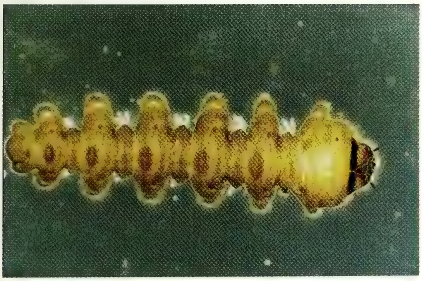
A. *Oreixenica latialis theddora,* a subspecies of the Browns endemic to Mount Buffalo. Photo by David Crosby.



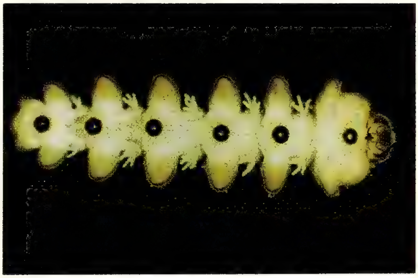
B. The larva of the chironomid *Symbiocladius aurifodinae* attached to larva of the mayfly *Austrophlebioides pusillus*, which was damaged during collection. Photo by John Hawking.

C. Larva of the dragonfly *Synthemis eustalacta.* Photo by John Hawking.

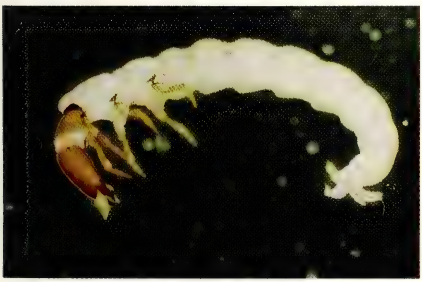
D. Larva of the stonefly *Austrocerca tasmanica.* Photo by John Hawking.



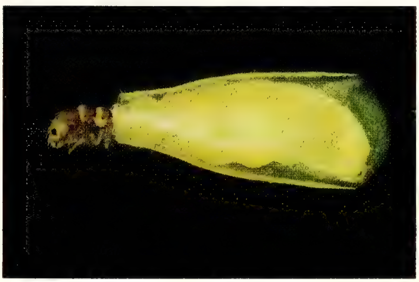
E. Dorsal view of the larva of the blepharicerid *Edwardsina.* Photo by John Hawking.



F. Ventral view of the larva of the blepharicerid *Edwardsina.* Photo by John Hawking.



G. Larva of the caddis-fly *Chimarra monticola.* Photo by John Hawking.



H. Larva of the caddis-fly *Oxyethira columba.* Photo by John Hawking.

PLATE 6

A. View from The Horn lookout. Photo by John Hawking.

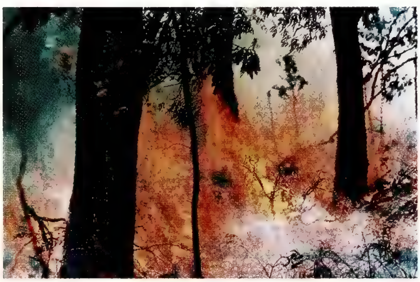
B. Mount Buffalo, looking towards snow-capped Mount Bogong. Photo by Malcolm Calder.

C. The Le Souef Area. Photo by Cameron Smith. Mount Buffalo Parks Victoria Collection.

D. Field of Billy Buttons *Craspedia* spp. Photo by Malcolm Calder.

E. Lake Catani, Mount Buffalo. Photo by Malcolm Calder.

F. Wild Dog Plain. Photo from Peter Jacobs.



G. Control burn on Mount Buffalo by Parks Victoria. Photo from Peter Jacobs.

H. Running Jump Creek. Photo by John Hawking.

Mount Buffalo

The Victorian Naturalist

Volume 115 (6) December 1998

Wilsons Promontory Centenary Issue

Published by The Field Naturalists Club of Victoria since 1884

F.N.C.V.

This issue supported by Parks Victoria

Parks VICTORIA

Adapted from Parks Victoria map, by Anne Morton.

PLATE 1

A. .Corner Inlet, 1977. Photo by G. Wallis.

B. Norman Bay and Point from Tidal Overlook, 1975. Photo by G. Wallis.

C. .Lilly Pilly Gully, 1998. Photo by D. Meagher.

D. Calcarenite Cliffs, Darby Bay. Photo by G. Wallis.

PLATE 2

The Wilsons Promontory Special Issue – Celebrating the Centenary of National Parks in Victoria

Robert Wallis[1]

This special issue of *The Victorian Naturalist* contains papers on the natural history of Wilsons Promontory National Park. It forms part of the celebrations of the centenary of national parks in Victoria by the Field Naturalists Club of Victoria which have included a special issue of the journal on Mount Buffalo National Park as well as having scientific excursions to the two parks which have been attended by Club members and friends.

Wilsons Promontory National Park was established on July 8th 1898 after 13 years of political lobbying by early members of the Club. Gillbank's article describes, however, the hard road the FNCV and subsequently, other like-minded societies had in persuading the government of the day to provide security for the park from settlement, mining, logging and hunting. It was not until seven years later that most of what we know as Wilsons Promontory National Park was permanently reserved.

This collection of articles highlights the importance of the Prom scientifically, historically and culturally. It contains accounts of aspects of the fauna (Seebeck and Mansergh, Thomson *et al.*), flora (Gillbank, Chesterfield, Hunter), geology (Wallis, Birch) and history (Gillbank, Ducker, Meagher, Meagher and Scott). These are complemented by papers on fire (Chesterfield), dieback (Weste), scientific significance (Wescott) and personal recollections of 75 years of visits by Gretna Weste. Sheila Houghton's bibliography of articles and references to Wilsons Promontory which have appeared in *The Victorian Naturalist* will be immensely valuable to naturalists and scholars.

The FNCV is proud of its past and present roles in ensuring the conservation of the natural environment at Wilsons Promontory. This special issue of *The Victorian Naturalist* is one example of the club's continuing interest in and commitment to the Prom which we believe supports the observation made by J.B. Gregory and Arthur Lucas after an 1885 trip by three field naturalists to the Wilsons Promontory lighthouse:

> 'We may safely commend the promontory as full of interest to naturalists of all persuasions. Practically inaccessible as it is at present we believe that a future awaits it as a summer haunt of lovers of nature, lovers of scenery'.

The Council of the FNCV thanks the authors of the articles and Parks Victoria for a financial contribution to production of the issue. As well, we acknowledge the excellent work of the editors in bringing the project to fruition.

[1] School of Ecology and Environment, Deakin University, Rusden Campus, Clayton, Victoria 3168. Immediate Past President, FNCV.

Australian Natural History Medallion
Peter Menkhorst

The 1998 Medallionist

The club is pleased to announce that this year's winner of the Australian Natural History Medallion is Peter Menkhorst, zoologist. He is a senior Wildlife Policy Officer, Flora and Fauna Statewide Programs, NRE, and editor of 'The Mammals of Victoria'.

The Presentation was made at the General Meeting of the Club on 9 November 1998, at the FNCV Hall.

Congratulations Peter.

The Victorian Naturalist

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Editors: Ed and Pat Grey
Assistant Editor: Merilyn Grey

Wilsons Promontory Articles

ISSN 0042-5184

Cover: FNCV Excursion Christmas 1912. Lunch at the head of Barry's Creek. Photo courtesy Historic Places Section, NRE.

Find us on the WEB: http://calcite.apana.org.au/fncv/

Of Land and Game: The Role of the Field Naturalists Club of Victoria in the Establishment of Wilsons Promontory National Park

Linden Gillbank[1]

Abstract
Following a walking trip through Wilsons Promontory in the summer of 1884-85 by three FNCV members, the Club spent two decades attempting to reserve the Prom permanently as a national park. With support from an increasing number of societies they organised deputations and public meetings. In 1898, under the Land and Game acts Wilsons Promontory, below the isthmus, was reserved temporarily as a national park whose indigenous fauna was protected from slaughter. In 1905 all but the coastal strip was reserved permanently and.in 1908 the coastal strip was included in the permanently reserved National Park and a committee of management appointed.
(*The Victorian Naturalist* **115** (6), 1998, 266-273)

Introduction

Four lodges at Tidal River carry the names of early members of The Field Naturalists Club of Victoria (FNCV) who deserve recognition in Wilsons Promontory National Park - George Robinson, an engineer elected to the Club in July 1880; Arthur Lucas, a biology teacher elected in March 1883; John Gregory, a lawyer elected in July 1883, and Baldwin Spencer, biology professor (and later museum director) elected in August 1887. Lucas was Club president during the 1880s and Spencer during the 1890s.

In the 1880s the concept of a national park was a shimmering diversity. Two reserves established in the 1870s in the USA and NSW were called national parks, and a Maori chief's mountain gift in September 1887 would become a national park in New Zealand. The efforts to reserve a national park on the Prom were protracted and the results at times elusive, with waves of frenetic activity interspersed with quietude born of a mistaken belief in political acquiescent action. There were deputations to government ministers and public meetings. FNCV monthly meetings were held in the Royal Society's Hall and those at which the Prom was discussed were well-attended, the number present rarely dropping below fifty. Since the Royal Society of Victoria and the FNCV shared membership as well as meeting space, their close collaboration in efforts to reserve Wilsons Promontory as a national park is not surprising.

[1] History and Philosopy of Science Department, University of Melbourne, Parkville, Victoria 3052.

This is the story of the efforts of Robinson, Lucas, Gregory, Spencer and others as it emerges in the proceedings of monthly and annual Club meetings, and articles and notices in the first 25 volumes of *The Victorian Naturalist* (which Lucas edited until he left Melbourne in 1892). It spans two decades and involves many individuals and institutions.

Towards Reservation

The saga began with a summer walking trip in search of health, recreation and specimens. After Christmas 1884, Gregory, Lucas and Robinson followed the track south from Yanakie pastoral station to the lighthouse on the south-eastern tip of Wilsons Promontory, where they were welcomed as the first tourists known to have reached the lighthouse overland. Gregory and Lucas (1885) commented that sportsmen had 'not yet made the Promontory desolate' and the native fauna could 'still be observed, undisturbed in their proper haunts'. They commended 'the Promontory as full of interest to naturalists of all persuasions' and saw it as a future summer haunt of lovers of nature and scenery. Gregory and Lucas (1885) prophesied that improved communication would soon enable Victorians 'to find out and do justice to this noble granite Promontory'.

In 1887 they were jolted into action to preserve the natural splendor of the Prom by news in the *Argus* of July 9th - 13th that a philanthropic Mrs Baillie, in search of land to settle needy Skye crofters, was attempting to secure a grant of 45000 acres

of 'poor scrubby land' on which the Prom, vacated by its pastoral lessee, provided no revenue to the government. Opposition came from various sources (Lennon 1974) including the FNCV. At the monthly FNCV meeting in August 1887, the president, Arthur Lucas, nominated his fellow Royal Society member, the University of Melbourne's newly appointed professor of biology, W. Baldwin Spencer, for election to the Club and John Gregory put two resolutions aimed at securing the permanent reservation of Wilsons Promontory as a national park. Firstly -

> 'That it is desirable that steps be taken to secure the vesting of Wilson's Promontory, and the islands and waters adjoining, in a board of Trustees, for the purposes of a national park, for the preservation of the fauna and flora, for the conservation of the fisheries, and for public recreation.'

This motion was carried unanimously, and it was decided to seek support from other societies. Hence the second motion:

> 'That the Royal, Geographical, and Zoological Societies be asked to join in making strong representations to the Ministers of Lands and Customs on the subject; and, if necessary, the president and hon. secretary wait upon the Ministers, in order to more fully explain the Club's views.'

While Lucas, with some help from Spencer, ensured Royal Society support (Mulvaney and Calaby 1985), the FNCV honorary secretary, F.G.A. Barnard, contacted the Royal Geographical Society of Australasia and the Zoological and Acclimatisation Society of Victoria. The Royal and Geographical societies proffered their support, but, despite subsequent representations by Lucas and Gregory, the Zoological society did not. At the FNCV meeting in September 1887, a subcommittee was appointed to draw up details of the proposal and submit them to the Minister of Lands, John Dow. On September 21st Barnard informed Dow of the Club's resolutions and the support of the Royal and Geographical societies. The following day the secretary for lands informed the Club that there was 'no legal occupation south of Yanakie, excepting the Lighthouse and quarters'.

On 21st February 1888 a joint deputation representing the FNCV, the Royal and Geographical societies and the Academy of Arts met Dow to discuss the reservation of Wilsons Promontory as a national park. During his FNCV presidential address in April, Lucas reported that the deputation pointed out 'the peculiar advantages of the Promontory ... its natural and effective boundaries, its variety of scenery, its future accessibility, the absence of vested interests, and the utility of part as a forest (kauri) reserve', and was well received. Lucas hoped that Victoria would follow the 'good examples' set by the USA, NSW and New Zealand, and 'preserve this wild locality as a recreation ground for the colony'. Four days after the deputation Barnard sent Dow information about the NSW national park hoping that, for very little expenditure, he would 'keep that almost insular tract of land intact as a recreation ground for future generations of Victorians'. At the FNCV meeting in March 1888, Barnard reported that 'there was every probability that the greater part of the peninsula would be reserved'.

That expectation was not limited to the FNCV. In April 1888 the *Yarram Chronicle* described Wilsons Promontory as 'the future People's Park, the sanitorium of Victoria, the most picturesque spot in the Colony' (Lennon 1974).

Meanwhile, the FNCV succeeded in convincing the government to reserve an area elsewhere as a forest reserve. The *Victoria Government Gazette* of 22 March 1889 described land in east Gippsland which was reserved under the Land Act '*temporarily* from sale and leasing etc for the Growth and Preservation of Timber'. It abutted two other forest reserves established in 1887 and 1888. There was no such gazetting for Wilsons Promontory. Instead, an area on the tip of the Prom's Singapore Peninsula was reserved for the future township of Seaforth (McKellar 1993).

At the FNCV meeting in March 1890, Gregory reminded the Club of the two-year silence following Dow's professed intention to reserve Wilsons Promontory. This prompted a flurry of letters to and from Secretary Barnard. The Secretary for Lands replied that the Minister proposed 'to reserve the larger portion as a State Forest, and to sanction its use ... for the purposes of a National Park' but the boundaries were not yet determined. A letter to George Perrin, Conservator of State

Forests, prompted his long reply on April 1st extolling the importance of state forests under the control of government rather than trustees. He intended 'to recommend nearly the whole of Wilsons Promontory to be reserved as a State Forest' and asked the Club 'to become its sponsors and to see that no one be he democrat or conservative shall deprive the Public of Victoria of this grand Reservation without a vigourous protest from the Club'.

Following a special FNCV meeting on April 2nd to discuss the matter, a FNCV deputation - Gregory, Lucas, Barnard, and the President, C.A. Topp - met Dow on May 7th to ask that the greater portion of the Prom might be permanently reserved for the conservation of indigenous fauna and flora and vested in trustees for a national park, and urged the inclusion of nearby rocky islands. Dow claimed that the government agreed with the objects of the deputation and that, excluding the Seaforth site, the Prom would be 'permanently reserved for State forest purposes', which he preferred to vesting such a large area in trustees. Regulations would be prepared by the Lands Department and submitted to the Club for approval. He added that the reservation would not interfere with the fishing industry at Waterloo Bay, Refuge Cove, or Corner Inlet. The Club deputation left feeling 'very pleased at the success of their mission' (Anon. 1890).

Again a false sense of success. As in 1888, an apparently favourably received deputation fed the expectation of a Prom reserve, this time as a state forest. Again the promised reservation was reported in a FNCV presidential address (in April 1890) and at a monthly meeting (May 1890).

During the late 1880s Dow had tripled Victoria's forest reserves, but his ministerial career was interrupted in May 1890 and curtailed in 1893 (Dow 1972). The Prom was never a forest reserve. Dow's successor prepared legislation that allowed the reservation of Wilsons Promontory as a national park. During the 1890s Robert Best was the Commissioner of Crown Lands and of Customs (which included game). In 1896 Best's amendment bill to the Game Act allowed the protection of Victoria's indigenous fauna in particular localities. Ironically they had to be defined as 'game' to gain protection from slaughter! Best (1896) mentioned 'an extremely important provision' of his amendment bill - that

> 'the Governor in Council may, by proclamation in the *Government Gazette*, specify any part of Victoria as a locality in which, during certain fixed periods of the year, it shall be unlawful for any person to kill or destroy any native game, ...'

Furthermore, it enabled the minister 'to proclaim certain areas national parks, wherein native game can be conserved' (Best 1896). Now Wilsons Promontory and other areas could be reserved from sale and their indigenous fauna protected from slaughter.

Later, as Commissioner of Crown Lands and Survey, Best authorised the reservation of Wilsons Promontory as a site for a national park - ca 91000 acres beyond the isthmus, excluding Seaforth, the lighthouse reserve and an allotment at Refuge Cove. Notice of the reservation was published in the *Government Gazette* of 8 July 1898. Four months later, as Commissioner of Trade and Customs, he signed the proclamation (under the Game Act) of the national park on Wilsons Promontory as a locality within which 'during the whole year' it was 'unlawful for any person to kill or destroy any native game' - where native game meant 'all Australian fauna, except snakes'. The proclamation was published in the *Government Gazette* of 4 November 1898. As the first Victorian locality to be proclaimed for all indigenous animals for the whole year (Norman 1981) Wilsons Promontory National Park provided the first Victorian year-round sanctuary for all indigenous birds and animals (except snakes).

The reservation of Wilsons Promontory as a national park was acknowledged in a short notice in *The Victorian Naturalist* of September 1898:

> 'Members will be pleased to learn that the agitation commenced some years ago by this Club has resulted in Wilson's Promontory being proclaimed a national park for the preservation of native fauna. *Vide Government Gazette*, 8th July, 1898.'

No doubt members were pleased - unless they noticed the absence of the word permanent, or read the *Government Gazette*. But they were worried about the efficacy of the proclamation under the Game Act. At the FNCV meeting in December 1898 concern was expressed that visitors may

not respect the protection of the Prom fauna and the Secretary was instructed to write to the Customs Department.

A Permanent Park

1904 brought shock horror. The Club learned that the new Minister of Lands, John Murray, had decided to subdivide the Prom into small grazing blocks, and sought information about the status of the Prom reserve. Assisted by A.D. Hardy, a Club member who worked in the Lands Department, they discovered that they 'had been living in a fool's paradise' (Hall 1905). No part of the Prom was permanently reserved. As the *Government Gazette* had clearly and unambiguously reported in July 1898, the national park had been reserved '*temporarily*'. As a temporary reserve, the Prom was under the absolute control of the Minister and could be subdivided at will.

The threat of subdivision provoked immediate FNCV and Royal Society action. Frank Wisewould (FNCV vice-president) interviewed officers of the Lands Department and notified the Royal Society, whose secretary Thomas Hall wrote to Murray asking that he delay action until a deputation could be arranged. Behind the scenes the Royal Society President and Director of the Museum, Professor Baldwin Spencer, was busy urging and influencing. In one week he met the Speaker of the Legislative Assembly, Chairman of the Board of Works, and President of the Australian Natives' Association (ANA) (Mulvaney and Calaby 1985). At the FNCV meeting in September 1904, the President (O.A. Sayce), Hall, and Wisewould were appointed to represent the Club. Hastily prepared in only two days, the deputation on September 14th included representatives of six societies. The FNCV and the Royal and Geographical societies were now supported by the Ornithologists' Union, the Zoological and Acclimatisation Society and the Board of Directors of the ANA. The deputation was introduced by Frank Madden, Club member and Speaker of the Legislative Assembly. Professor Spencer explained the details (Hall 1905).

The deputation was successful and the proposed subdivision was cancelled. But the Park was still not reserved permanently and Sealers Cove was being logged. Spencer and Hall decided on a public meeting and Spencer's letter to the press provoked interest and support. A strong campaign committee met at the Town Hall and Spencer was appointed secretary. Sir John Madden, Lieutenant-Governor and brother of Frank, presided over the public meeting in the large Athenaeum hall on 7 October 1904. Spencer spoke. The park should be a heritage of the people for ever. E.G. Fitz Gibbon, who had fought a long battle for people's parks, proposed resolutions affirming the desirability of reserving the Prom as a permanent national park and having it vested in trustees. The resolutions were carried unanimously. Dr Carty Salmon, representing the ANA, and Frank Madden spoke in support. A large deputation was selected to lay the resolutions before the Premier and the Minister of Lands (Hall 1905). At the October FNCV meeting, 150 members and visitors heard Sayce's hopeful report of the meeting and resolutions.

The deputation to Minister Murray on December 7th was larger than the hastily prepared September deputation. Now there were representatives of eight societies, including the Victorian Anglers' Society and the Trustees of the Public Library. Wisewould was the FNCV representative. Frank Madden, Professor Spencer and others spoke (Hall 1905). Later, at the December FNCV meeting Wisewould reported that 'the Government had decided to permanently reserve the greater portion of the Promontory, but the terms of the reservation had not yet been published'.

Murray was as good as his word. In 1905 a large part of the Prom was permanently reserved. The *Gazette* of January 25th reported that under the land act the inner 75000 acres of the site reserved temporarily in July 1898 would be reserved 'from sale, *permanently*' for a national park, and the *Gazette* of March 8th reported its permanent reservation. But it had no sea-frontage. A half mile strip right around the coast-line was excluded from the permanent reserve. And control was not vested in trustees. The FNCV presidential address delivered in June 1905 described the rush of Club activity since the previous September and regretted the exclusion of the coastal strip from the Prom's permanent reserve. Two

decades after Gregory, Lucas and Robinson had been charmed by the flora, fauna and scenery of the Prom, the coastal margin was still not protected permanently.

In the hope that an informed public and parliament would ensure the permanent reservation of the whole Promontory, the Club concentrated on gaining and publicising information about the Prom. They organised biological surveys and public meetings. At the FNCV meeting in June 1905 Hardy moved:

> 'That the inconsistencies of the present reservation destroy the usefulness of the Park, and the committee be empowered to take such action as may be necessary to urge the reservation of the whole area and its vestment in trustees.'

To obtain biological information, Hardy led a ten day Christmas 1905 and New Year 1906 excursion to the Prom, possibly the Club's most important excursion for many years. The naturalists accumulated photographic slides as well as specimens for data and display (Fig. 1). Now they could enlighten and entertain the public.

The FNCV provided an illustrated discussion of Wilsons Promontory National Park in the Masonic Hall on 8th February 1906. Over 100 lantern slides from the Club's Christmas excursion delivered the Prom's biological and scenic splendours to a huge audience of about 1000 people. They listened as Thomas Hall explained that the Prom reserve should not be considered merely as a national park for Melbourne or even for Victoria, but must be regarded as an Australian sanctuary for representatives of its unique fauna, where they could be studied in their natural state. Under certain restrictions it might even become a tourist resort. With its sand dunes, tea-tree river flats, bold granite masses and sandy beaches, the Prom was eminently suited for the type of park desired by the Club, and under proper control, could become 'a most valuable asylum for our rapidly diminishing indigenous animals'.

> 'The beauty of many of the pictures appealed to the tastes of the audience, and the lecturer was frequently interrupted by expressions of approval.' (Anon. 1906)

At the FNCV meeting in February 1906, Hardy provided a detailed botanical report and information on its suitability as an asylum for indigenous animals. The scientific results of the Club's Prom excursion - botany, zoology, geology - were published in *The Victorian Naturalist*. In his botanical report Hardy (1906) pointed out that the vegetation was not of economic importance - only a little commercial timber at Sealers Cove and very little grazing land - but would 'afford shelter and sustenance to such of our animals and birds peculiar to Australia as it may be desirable to protect and allow to increase'. In his excursion report Hardy (1906:196) noted that the sawmill at Sealers Cove was 'destroying the best gullies and 'Lyre-bird' country of the Park'. The FNCV annual report presented in June 1906 discussed the Prom excursion and the need to include the coastal strip in the permanent reserve. With the 'erection of a rabbit-proof fence at the north-western corner [across the isthmus], the destruction of the wild dogs, and the appointment of a ranger', the national park would 'afford a safe refuge for our fast-disappearing native fauna'.

In 1907 Professor Spencer agreed to initiate further action. He sent letters to interested societies and institutions, asking each to nominate two members as their representatives at a conference to consider approaching the government on the matter. G.A. Keartland (president) and A.J. Ewart, Professor of Botany at the University of Melbourne and Government Botanist, represented the Club. At the conference held in the Trustees' Room in the Public Library on 29 November 1907, Spencer was appointed chairman. The Honorary Secretary was the museum curator, James Kershaw, who had prepared the zoology report for the Club's Prom excursion. It was decided unanimously to ask the government:

> (1) To reserve permanently the whole of Wilson's Promontory as a National Park for Victoria; (2) to vest the National Park in trustees; (3) to appoint a ranger to act as custodian of the National Park; (4) to request the Hon. the Minister of Lands to receive a deputation on the subject. (This was reported at the FNCV meeting in December 1907).

By 1907 John Mackey was the lands Minister. On 18th December a deputation of representatives of eight Victorian societies and institutions, met Mackey. Spencer explained the deputation's desires.

Oberon Bay camp.

Oberon Bay camp - a beautiful sheltered flat behind a beach sand dune.

J.A. Kershaw searching for the crustacean *Hymencoma pacutris* in Fraser Creek, Oberon Bay.

Mrs. A.D. Hardy with *Veronica derwentia* at the entrance to Oberon Flat. Mount Norgate behind.

FNCV members at Oberon Bay.

Darby River camp - T. Hall (left), A. Kershaw sitting (right).

FNCV party at lunch - left to right, camp assistant G. Macey, G. Pritchard, J. Leach ?, J.A. Kershaw, A.D. Hardy, Armitage, T.Hall.

FNCV party - return journey along ocean beach, north of Darby River.

Fig. 1. The FNCV Christmas Excursion to Wilsons Promontory 1905-1906. Photos courtesy Historic Places Section, N.R.E.

Mackey claimed to concur. However he was sure that the Cabinet would not agree to include the half-mile margin in the permanent reservation, but he would give the trustees control over it. Revenue from the existing grazing leases would go to the trustees for the Park's management and he would appoint a ranger and make him an officer of the trustees. Mackey explained that, although reserved permanently, the land was still subject to the mining laws, and the timber was under the control of the Forestry Department. At the FNCV meeting in January 1908 Keartland relayed the above details and Professor Ewart bemoaned ongoing damage to the Park as long as timber-cutting rights were granted.

At a second meeting of the conference early in 1908, a list of representatives of the eight societies and institutions was submitted to the Minister for their appointment as trustees. However, on approving these nominations, Mackey constituted them a Board of Management. FNCV vice-president, Professor Ewart, represented the Club. In his FNCV presidential address delivered in June 1908, Keartland reported the above and his deep regret that Mackey did not include the half-mile coastal margin in the permanent reserve.

> 'Encouraging progress has, however, been made, and the Club has now good reason to expect a successful outcome of its long and earnest endeavours to secure this area as a permanent sanctuary for our native fauna and flora.'

Professor Spencer was thanked 'for the whole-hearted manner in which he has urged on this movement on every possible occasion, and to whom much of the success attending it is due', and the Club's 'hearty appreciation' was recorded for the support of the ANA directors.

Representations to Mackey were successful. The *Victoria Gazette* of 1st July 1908 reported the temporary reservation of the Prom's coastal strip and the *Gazette* of July 8th and August 19th recorded its permanent reservation. However it was designated a multipurpose area. It was reserved 'for a National Park and for Sites to establish, when required, Pilot Stations, Lighthouses and other Aids to Navigation'. The *Gazette* of August 19th also reported the appointment of eleven members of the honorary Committee of Management for the whole permanently reserved area. The Honorable C.C. Salmon, T.S. Hall*, A.J. Ewart*, F.R. Godfrey*, J.A. Panton, A.H. Mattingley*, F. O'Dee, and W.B. Spencer* represented eight societies and institutions, and C. W. Maclean, W. Thorn*, and A.A. Peverill represented the Departments of Customs, Mines and Lands. (The six with asterisks were FNCV members).

Kershaw had good news for the FNCV at its meeting in September 1908 - Professor Spencer's election as chairman of the Board of Management of Wilsons Promontory National Park, which now included the coastal strip, except the lighthouse reserve and small areas at Sealers Cove, Refuge Cove, Waterloo Bay, Oberon Bay, and Mt Singapore. These areas, although under the control of the board, would be set aside as landing-places for fishermen and others.

The end as a new beginning

Thus, in August 1908, after five deputations to three lands Ministers, two public meetings, two conferences and one Club excursion, waves of concerted activity by the FNCV and a growing number of other organisations eventually culminated in achieving what Gregory, Lucas, Robinson, Spencer and other Club members sought in 1887 - the permanent reservation of Wilsons Promontory as a national park for the preservation of the flora and fauna and for public recreation. By then Wilsons Promontory National Park was also seen as a sanctuary for Australian animals, even those whose native habitats were outside the Prom.

Inside and outside the Park decisions and deeds quickly followed. A vermin-proof fence was required across the isthmus to prevent the entry of rabbits and wild dogs, (Fig. 2) and indigenous animals thought to be facing extinction were sought to introduce into the Park. Under Ewart, the National Herbarium began a comprehensive botanical survey of the Park, and a ranger was appointed. At a public meeting in Melbourne in December 1908 an organisation was inaugurated - the National Parks Association.

Thus the protracted Prom experience led to the establishment of Wilsons Promontory National Park and an organisation to seek the reservation of other Victorian national parks.

Fig. 2. The Park Fence 1922. Photo courtesy Historic Places Section, N.R.E.

Acknowledgements
I thank Sheila Houghton and Angela Taylor for information about FNCV correspondence, and the editors for selecting illustrations.

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The Second FNCV Wilsons Promontory Christmas Camp 1912-1913

'The prominence which has been given to the National Park at Wilson's Promontory during the last few years, and the very pleasant recollections of the previous visit undertaken under the auspices of the Club, together with the keen interest taken by the members in all matters pertaining to the Park, encouraged the committee to select this locality for a second Christmas camp....

Bennison - luggage off-loaded. Photo courtesy Historic Places Section, NRE.

By boat to 'Vereker' landing. Photo courtesy Historic Places Section, NRE.

On the present occasion it was decided to confine our attention chiefly to the Vereker Range and its vicinity. The range is closely adjacent to the landing-place, at the extreme south-west corner of the Inlet, and, running south to Mounts Vereker and Leonard, forms the northern end of the central range.'

'Leaving Melbourne by the 7.27 a.m. train on Thursday 26th December, we reached Bennison at 1.30 p.m. From here we continued our journey for another mile and half by horse tram–a rather novel and primitive means of conveyance–to Port Welshpool, a small fishing village, until quite recently known as Bowen, situated on the Franklin River, ... Here, ..., the luggage was transferred to the two motor boats, and everything prepared for an early start. All being ready, we left Port Franklin about 3 o'clock, ...'

Extracts from *The Victorian Naturalist* **29**, 163-170

A Challenge – 75 Years of Walking in Wilsons Promontory, 1923 – 1997

Gretna Weste[1]

Abstract
The author, a long-time member of the FNCV, relates her personal memories of holidaying at Wilsons Promontory over 75 years. This article relates the early rugged walking and camping experiences up to the latest in 1997, which was somewhat less spartan, but again the weather provided its own challenge. (*The Victorian Naturalist* **115** (6), 1998, 274-278)

My first visit to Wilsons Promontory was in March 1923. My parents, my brother and I, (aged 4 and 5 years), travelled by train from Surrey Hills to Foster, taking all our camping gear and food for two weeks. At Foster we hired a horse and buggy for the journey to the park. The road was not then made and the last section was along the beach. We camped first at Darby River where there were small huts (Fig. 1) and then we walked to Tongue Point (Figs 2 and 3) and its island, surfed at the mouth of the river, and played in the sand (Fig. 4). My parents swam in the Darby River near the bridge (Figs 5 and 6), where there was a diving board. They wore neck-to-knee navy bathers with a white border around the crew style neck and legs, really a T-shirt and shorts in loose cotton material. The family rule stated that we had to be able to swim before reaching four years, for which the reward was one shilling. However, the river was too deep and we were just dipped in and out. Very mortifying for a 5-year-old. With the aid of a horse we moved camp to Titania Creek, somewhere near Tidal River (Fig. 7) and we walked to Sealers Cove, taking

Fig. 1. Hut at Darby River.

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overnight gear. My brother and I each carried a grey ex-army blanket in a school bag. At Sealers Cove we slept in an old box-shaped rusty iron tank (Figs 8 and 9), which contained piles of bracken indicating previous occupancy. My parents used large khaki ex-army rain capes which doubled as ground sheets. We walked to Lilly-Pilly Gully (Pl 2C) and climbed Mount Oberon and I remember a daytime sleep on the granite slopes surrounded by pungent scented heathland.

Later I introduced my own children to camping at Wilsons Promontory. My husband, a forester and radio engineer with the Forests Commission of Victoria, set up the radio communication system for the park in the 1950s. One particular camping

Fig. 2. Curious cattle on the way from Darby River to Tongue Point.

Fig. 3. Tongue Point from Leonard Bay.

trip, in May 1957, stands out. I had hired 5 canvas A-frame back packs from the local Sea Rangers so we could provide a challenge of three overnight walks for our children of 7, 11 and 14 years. Unfortunately 11inches (275 mm) of rain fell in the park in that one week (Fig. 10).

Our first overnight walk was to Sealers and Refuge Coves, but in the heavy rain all the tracks became creeks. We only recognised a creek crossing because the lead walker disappeared under the water, re-emerging on the opposite side. Our canvas packs soaked up the water and steadily increased in weight. We crossed one river with all our clothes piled high on our heads. That night we camped at Refuge Cove, where the rain blew horizontally bearing quite large fish which landed all around us. Our old style tents had no floors and the rain lashed us all night so that our sleeping bags were saturated. No fire was possible in the morning so we breakfasted on bread spread with blackcurrant jam, dried milk and egg, our worst ever breakfast. Despite everything, we managed to barbecue meat for lunch.

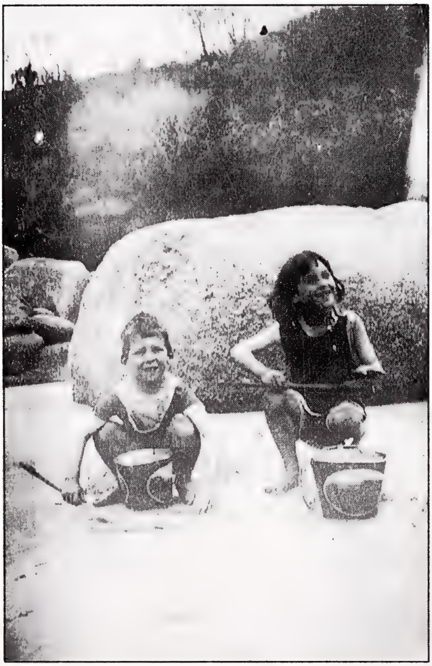

Fig. 4. Gretna (author) and Cliff (brother) playing on the beach at Darby River.

Our second overnight walk in that week was to the lighthouse. We camped at Roaring Meg (Back Cover B)– thunder roared, lightning flashed, rain fell and Roaring Meg rose alarmingly, and we were deluged yet again. However, we had a permit to see over the lighthouse, and that was fascinating. The light itself was a small kerosene lamp, magnified by mirrors and prisms. The lighthouse keeper on duty had to wind the light turning mechanism manually by 19 turns every hour. Five families lived in the cottages and their children were boarded at school. Their only access to the lighthouse from the cottages was by gantry from a ship moored on either the east or the west of the promontory according to wind direction. We were all very impressed and sent them magazines regularly for some years. I have

Fig. 5. Diving board on Darby River.

Fig. 6. Access at Darby River.

never forgotten the thrill of seeing large ships passing through that rocky treacherous sea between the promontory and the nearest island, Deal Island.

Our third walk was to be Chinaman's Bay. We camped in the Vereker Range and were happily singing songs around the camp fire, when suddenly, guess what?

Fig. 7. On the track with Hebe the horse, moving camp from Darby river to Oberon Bay.

Fig. 8. Camp at Tidal River.

Fig. 9. Campout at Sealers Cove. The small tank we slept in is on the left.

Thunder roared, lightning flashed, and rain fell. We packed up and returned to Melbourne.

Since then I've made many more trips to Wilsons Promontory. There was the period when an imprinted Wedge-tailed Eagle was in residence. This huge bird loved small boys and would land beside my son, hop along, untie his shoelaces and play kick the tin and other games.

In 1961 the botany lab was opened at Wilsons Promontory, and as a staff member, I demonstrated on botany excursions for second year students. On our free day we walked to the lighthouse and back. In 1970, I detected the Cinnamon Fungus *Phytophthora cinnamomi* in the heathland and we set up plots to study this previously unknown killer of our native plants (see later article).

Last October (1997) I spent a week walking at the Prom, revisiting all the major scenic areas, even walking to the lighthouse and back. But, alas, how soft I've grown! I slept in a cottage, and spent a day walking around the tip of the promontory, before returning to Tidal River. Only the weather continued to provide a challenge. It rained and blew with a ferocity known only to the Prom.

Fig. 10. Trekking in the rain in May 1957.

Winds of 180 knots kept even the lighthouse keeper from his viewing platform. Electricity for the lighthouse and that for the adjacent cottages now comes from a wind turbine. All access is by helicopter.

Wilsons Promontory has provided me with wonderful recreation and bushwalking for 75 years! Will the same challenge be available for the next 75 years?

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Bell, K.N., and Plant, R.J. (1977). Cuttle Bones on Victorian Beaches. (illus.) **94**, 115-118.
Sepia apama, *the most common and largest species, occurs on Wilsons Promontory.*

Bell, K.N., Neil, J.V., and Burn, R. (1995). Recent Foraminiferal, Ostracodal and Molluscan Changes in a Short Core from Corner Inlet, Victoria. (map) **112**, 72-78.

Burn, R. (1959). Molluscan Field Notes, Part 2. (illus.) **75**, 147-150.
Conuber conicum *(Lamarck) 1822;* Conuber incei *(Philippi) 1851;* Thalassohelix transluscens *(Gabriel) collected from Wilsons Promontory.*

Burn, R., and Bell, K.N. (1976). Cryptic Molluscs Inhabiting *Galeolaria* in Victoria. (illus.) **93**, 232-236.
Two species collected from Shallow Inlet.

Carolan, P.M. (1959). Mallee and Dwarf Eucalypts. **76**, 127.
Dwarf Eucalyptus globulus *at Squeaky Beach.*

Carolan, P.M. (1976). Eucalypts Along the Victorian Coast: Notes on the Victorian Ocean Coastline with Reference to Aspect and Distribution of Eucalypts. **93**, 246-249.

Coghill, E.H. (1965). Wilson's Promontory Botanical Bibliographical Notes. **82**, 210.
Includes other sources besides The Victorian Naturalist.

Coleman, E. (1926). Orchids at the National Park. **43**, 211-212.

Coleman, E. (1950). George Bass, Victoria's First Explorer and Naturalist. **67**, 3-9.
Discovery of Wilsons Promontory.

Cooper, J. (1965). Photograph of Stranded Pilot Whales, *Globicephalus melaena*, at Waterloo Bay, Wilson's Promontory. **82**, 97 (Caption 99).

Corrick, M.G. (1976). Bush-peas of Victoria - Genus *Pultenaea* No.1. (illus.) **93**, 176-179.
Pultenaea daphnoides *recorded from Wilsons Promontory.*

Corrick, M.G. (1976). Bush-peas of Victoria - Genus *Pultenaea* No.2. (illus.) **93**, 250-252.
Pultenaea canaliculata *and* P. prolifera *occur on Wilsons Promontory.*

Corrick, M.G. (1977). Bush-peas of Victoria - Genus *Pultenaea* No.3. (illus.) **94**, 20-28.
Distribution of Pultenaea gunnii *and* P. stricta *includes Wilsons Promontory.*

[1] 12 Scenic Court, Gisborne 3437.

Corrick, M.G. (1977). Bush-peas of Victoria - Genus *Pultenaea* No.4. (illus.) **94**, 68-70.
Distribution of Pultenaea tenuifolia *includes Wilsons Promontory.*

Corrick, M.G. (1987). Bush-peas of Victoria - Genus *Pultenaea* Sm. (Fabaceae) - 22. (illus. map) **104**, 141-144.
Pultenea hispida *occurs on Wilsons Promontory.*

Daley, C. (1924). Excursion to the National Park, Wilson's Promontory. **40**, 212-220.
Report of 4th Club excursion given to FNCV Ordinary monthly meeting 14 January 1924, 40, 185-186.
Accommodation at the new Chalet much appreciated; Myrtle Beech (Nothofagus cunninghamii) *ascertained to grow at Sealers' Cove.*

Daley, C. (1925). Excursion to the National Park. (illus.) **41**, 204-210.
5th Club excursion.

Daley, C. (1926). Excursion to Wilson's Promontory. **42**, 256-259.
6th Club excursion.

Daley, C. (1928). Excursion to Sealers' Cove. **44**, 303-305.
Account of this excursion given to FNCV Ordinary monthly meeting 13 February 1928, illustrated by lantern views from photographs taken by L.L. Hodgson and H.P. Dickens. **44**, 297.

Early Naturalists Writings 1 (1972). **89**, 336-343.
Reprint of excerpt from J.A. Kershaw's Excursion to National Park, Wilsons Promontory, 1915.

Edmonds, J.W., Nolan, I.F., Shepherd, R.C.H., Backholer, J.R., and Jackson, R. (1976). Rabbits on Gippsland Islands. **93**, 110-112.
Origins and evolution of rabbit populations.

Ewart, A.J. (1909). Biological Survey of Wilson's Promontory, 1st report (map): Botanical Report, by J.W. Audas; Zoological Report, by P.R.H. St. John. **25**, 142-151.

Ewart, A.J. (1910). Biological Survey of Wilson's Promontory, 2nd report: Botanical Report, by J.W. Audas; Report, by C.S. Sutton. **26**, 129-137.

Ewart, A.J. (1911). Biological Survey of Wilson's Promontory, 3rd report: Flowering Plants and Ferns. **27**, 178-180.

Field Naturalists Club of Victoria (1887). Monthly meeting. 8 August 1887. **4**, 66.
J.B. Gregory moved 'That it is desirable that steps be taken to secure the vesting of Wilsons Promontory, and the waters and islands adjoining, in a board of Trustees, for the purposes of a national park, for the preservation of the fauna and flora, for the conservation of the fisheries, and for public recreation'. Seconded by H.T. Tisdall, and carried unanimously.

Field Naturalists Club of Victoria (1887). Monthly meeting. 14 November 1887. **4**, 114-115.
The President, A.H.S. Lucas, and J.B. Gregory authorised to approach the Zoological Society seeking support for Wilsons Promontory National Park.

Field Naturalists Club of Victoria (1888). Monthly meeting. 12 March 1888. **4**, 197-198.
Joint deputation with the Royal and Geographical Societies, and the Academy of Arts, to the Minister for Lands concerning the proposed national park at Wilsons Promontory had been favourably received, and the reservation of the greater part of the peninsula was very probable.

Field Naturalists Club of Victoria (1890). Monthly meeting. 10 March 1890. **6**, 169.
Hon. Secretary directed to inquire of the Minister for Lands as to the boundaries of the proposed reservation at Wilsons Promontory. Sub-committee empowered to take any necessary action to secure the whole of the peninsula as a National Park.

Field Naturalists Club of Victoria (1899). Ordinary monthly meeting. 12 December 1898. **15**, 102.
Fears expressed that excursionists on S.S. Peregrine to Wilsons Promontory might not respect the total reservation of native game. Secretary instructed to write to the Customs Department, seeking the necessary protection.

Field Naturalists Club of Victoria (1904). Ordinary monthly meeting. 12 September 1904. **21**, 78-79.
F. Wisewould reported on the leasing of grazing blocks in land reserved for a National Park at Wilsons Promontory. Deputation to the Lands Department arranged to try to secure permanent reservation of land and vesting of it in trustees.

Field Naturalists Club of Victoria (1904). Ordinary monthly meeting. 10 October 1904. **21**, 89-90.
President, O.A. Sayce, reported on efforts towards securing the permanent reservation of Wilsons Promontory, for which there was enthusiastic public support.

Field Naturalists Club of Victoria (1905). Ordinary monthly meeting. 12 December 1904. **21**, 119.
F. Wisewould stated he had represented the Club on the deputation to the Minister for Lands regarding the permanent reservation of Wilsons Promontory; it was subsequently announced that the Government had decided on this, but terms of reservation had not yet been published.

Field Naturalists Club of Victoria (1905). Ordinary monthly meeting. 16 January 1905. **21**, 134.
F. Wisewould indicated on a map the most likely spots for the introduction and maintenance of native fauna. Residents in the surrounding districts regarded the locality as quite unfitted for a National Park owing to the barren nature of a great part of the area.

Field Naturalists Club of Victoria (1905).

Annual meeting. 12 June 1905. Annual Report 1904-1905. **22**, 40-41.
Club's involvement, and progress towards reservation.
General Business. **22**, 44.
A.D. Hardy moved 'That the inconsistencies of the present reservation destroy the usefulness of the Park, and the committee be empowered to take such action as mày be necessary to urge the reservation of the whole area and its vestment in trustees'. Motion seconded by A.H. Mattingley, supported by F. Pitcher. [Minutes show this was carried unanimously.]
Map of the reservation between 44-45.

Field Naturalists Club of Victoria (1906). Annual meeting. 11 June 1906. Annual Report. 1905-6. **23**, 59-60.
There had been a ten day excursion to Wilsons Promontory to gather information to support the claim for the site to be reserved as a National Park. The hope was expressed that the half-mile coastal strip would be added to the permanent reserve.

Field Naturalists Club of Victoria (1908). Ordinary monthly meeting. 9 December 1907. **24**, 137-138.
G.A. Keartland, Club representative, with Prof. A.J. Ewart, at the conference to consider permanent reservation of Wilsons Promontory as a National Park reported that a meeting was held on 29 November. Resolutions: 1) To reserve permanently the whole of Wilsons Promontory as a National Park for Victoria; 2) To vest the National Park in trustees; 3) To appoint a ranger; 4)To request a deputation to the Minister for Lands.

Field Naturalists Club of Victoria (1908). Ordinary monthly meeting. 13 January 1908. **24**, 150-151.
Report on deputation to Minister for Lands. Minister's response outlined. The matter to be pursued, and a meeting to be held to appoint trustees. A.D. Hardy spoke on trip to Sealers' Cove with friends at Christmas.

Field Naturalists Club of Victoria (1908). Annual meeting. 15 June 1908 28th Annual Report. **25**, 40-41.
Deputation to the Minister for Lands requesting reservation of the whole of Wilsons Promontory, the Park to be vested in trustees and the appointment of a ranger. Board of Management appointed; the half-mile coastal strip excluded from the Park; ranger to be appointed.

Field Naturalists Club of Victoria (1908). Ordinary monthly meeting. 14 September 1908. **25**, 90.
J.A. Kershaw reported the appointment of Professor Baldwin Spencer to the Board of Management. Messrs Sayce and Gatliff moved 'That the thanks of this Club be accorded to the Hon. the Minister for Lands for his efforts in securing the permanent reservation of the half-mile strip along the coast at Wilsons Promontory, and for his action in generally forwarding the movement'. Motion carried.

Field Naturalists Club of Victoria (1909). Ordinary monthly meeting. 8 February 1909. **25**, 171.
A.D.Hardy exhibited a specimen of Native Beech, Fagus cunninghami, *collected at Sealers' Cove.*

Field Naturalists Club of Victoria (1909). Annual meeting. 29th Annual Report. **26**, 28-29.
Appointment of a ranger; vermin-proof boundary fence not yet erected. The Club's set of lantern slides of the Promontory had been used before different audiences.

Field Naturalists Club of Victoria (1910). Annual meeting. 13 June 1910. **27**, 47.
Professor Ewart reported that several islands in Corner Basin had been reserved and added to the National Park.

Field Naturalists Club of Victoria (1911). Annual Report 1910-11. **28**, 45.
Club involvement in the protection of native game; the extension of the National Park northward to protect the water birds' feeding ground in the southern part of Corner Inlet.

Field Naturalist Club of Victoria (1912). Ordinary meeting. 15 April 1912. **29**, 1.
Correspondence: letter from A.J. Ewart concerning cattle grazing.

Field Naturalists Club of Victoria (1912). Ordinary meeting. 15 April 1912. **29**, 3.
J.A. Kershaw reported further introductions of native fauna.

Field Naturalists Club of Victoria (1912). Ordinary monthly meeting. 13 May 1912. **29**, 17.
Letter from Professor A.J. Ewart: acceptance of tenders for the grazing of cattle in the National Park had been postponed, pending inquiries into the question.

Field Naturalists Club of Victoria (1912). Annual meeting. 32nd Annual Report. **29**, 36.
The boundary fence had been completed. Introduced native fauna was thriving. Improvements were to include resthouses for camping parties, the opening up of new tracks and improvement of existing ones. An attempt was to be made to introduce the lyrebird in fern gullies.

Field Naturalists Club of Victoria (1913). Ordinary monthly meeting. 10 March 1913. **29**, 182.
F.G.A. Barnard referred to recent fires at Wilsons Promontory, and moved 'That a strong protest be made to the Committee of Management against further use of the National Park at Wilsons Promontory as a grazing area, on account of the danger of destruction of native flora'. Seconded by G. Coghill. There was a lack of uniformity in the name applied to Corner Basin, frequently referred to as Corner Inlet. Dr Hall said Corner Basin was known locally as 'The Inlet'.

Field Naturalists Club of Victoria (1913). Ordinary monthly meeting. 14 April 1913. **30**, 1-2.
Correspondence from J.A. Kershaw stating that the Committee of Management had directed that all stock shall be removed from the Park after June 1913. Discussion in General Business concerning the finances of the National Park as a result of this decision and Government funding.

Field Naturalists Club of Victoria (1916). Annual meeting. 12 June 1916. **33**, 40.
J.A. Kershaw reported the introduction of Woodward's Kangaroos (Macropus woodwardi).

Field Naturalists Club of Victoria (1918). Ordinary monthly meeting. 14 January 1918. **34**, 166.
J.A. Kershaw reported the planting of Cabbage Palms Livistona australis.

Field Naturalists Club of Victoria (1918). Monthly meeting. 12 August 1918. **35**, 75.
Professor Spencer reported moves to prospect for tin at Wilsons Promontory and moved 'That the President, Hon. Treasurer and Hon. Secretary be official representatives on any deputation occurring before the next meeting of the Club'. Seconded by P.R.H. St. John and carried unanimously. [Industrial affairs had assumed prominence because of the war.]

Field Naturalists Club of Victoria (1918). Ordinary monthly meeting. 9 September 1918. **35**, 88-89.
Professor Spencer reported that the deputation to the Minister for Mines concerning tin-mining at Wilsons Promontory was successful, but urged the utmost vigilance by the Club and individual members.

Field Naturalists Club of Victoria (1918). Ordinary monthly meeting. 14 October 1918. **35**, 104-105.
The National Park. The President, A.D. Hardy, reported that a trial under strict conditions of the alleged tin deposit at Wilsons Promontory was proposed by the Government. Professor Spencer said that if really valuable natural assets of tin were discovered mining must be allowed, since 'considerations of national welfare' must come first. G. Coghill asked if it were possible to get the Park properly proclaimed. J.A. Kershaw reported on progress, native fauna becoming well-established.

Field Naturalists Club of Victoria (1920). Annual Report. **37**, 44.
Successful introduction of native fauna and flora to Wilsons Promontory underlines its suitability as a permanent sanctuary.

Field Naturalists Club of Victoria (1924). Ordinary monthly meeting. 14 January 1924. **40**, 187.
Exhibits: a grinding stone of dune sandstone, also a flint core, from a coastal midden (C. Daley); flowers of Saw Banksia Banksia serrata; *Coast Banksia* Banksia integrifolia; *bark of* Melaleuca ericifolia; *quartz scrapers and flints, from aboriginal kitchen middens; quartz, showing bands of orthochrome clays; fossilized shell, all collected in January 1924. (L.L. Hodgson).*

Field Naturalists Club of Victoria (1924). Ordinary monthly meeting. 11 February 1924. **40**, 211.
Geological Survey of Victoria, per A.E. Rodda, an exhibit of epiphysis of a whale, found on the beach near Darby River.

Field Naturalists Club of Victoria (1939). Annual meeting. 13 June 1939. **56**, 34.
E.S. Hanks moved that the meeting protested against stocking Darby River with rainbow trout. Seconded by S.R. Mitchell, the motion was carried.

Field Naturalists Club of Victoria (1946). Monthly meeting. 8 April 1946. **63**, 1-2.
Safeguarding Flora and Fauna. P. Crosbie Morrison referred to the damage caused at Wilsons Promontory by Commandos in training during six years of war.

Field Naturalists Club of Victoria (1950). Monthly meeting. 12 December 1949. **66**, 162.
Nature note: Miss Elder had twice seen a Yellow-footed Marsupial Mouse, with a family attached, at Wilsons Promontory.

Field Naturalists Club of Victoria (1950). Monthly meeting. 9 January 1950. **66**, 182.
G. Hooke exhibited a Spindle-shaped Volute Ericusa sowerbyi *collected at Tidal River.*

Field Naturalists Club of Victoria (1954). General meeting. 12 July 1954. **71**, 54.
Exhibits: Fresh-water mussel Propehydridella cultriformis, *from Lilly-pilly Gully (J.R. Garnet); quartz showing paired tourmaline crystals on one face, and the impression of a similar pair on another face.*

Field Naturalists Club of Victoria (1961). General meeting. 10 April 1961. **78**, 23.
Discussion on the proposed hotel at Wilsons Promontory. Members to request that it be situated in the vicinity of Darby River.

Field Naturalists Club of Victoria (1961). General meeting. 8 May 1961. **78**, 48.
Report on the proposed hotel: the matter was in the hands of the National Parks Authority; the Government would respect their decisions.

Field Naturalists Club of Victoria (1961). Annual Report 1960-61. **78**, 53.
Club's protests over setting up of a farm had been successful; recommendation made that the proposed hotel should be situated in the Darby River area.

Field Naturalists Club of Victoria (1961). General meeting. 13 November 1961. **78**, 246.
J.R. Garnet reported the discovery of a gully with huge Lilly-pilly trees, two species of Tmesipteris *and the rare Jungle Bristle-fern* Macroglena caudata.

Field Naturalists Club of Victoria (1962). General meeting. 9 April 1962. **79**, 22-23.
J.R. Garnet exhibited photographs of the

FNCV visit to Wilsons Promontory in 1910; and a large chiton and sea-mouse (Aphrodite) from Corner Inlet. W.C. Woollard reported that Japanese (sic) *hog deer were very tame and friendly. There was new modern accommodation at Tidal River.*

Field Naturalists Club of Victoria (1962). General meeting. 10 September 1962. **79**, 176.
J.R. Garnet raised the subject of the possible establishment of a licensed hotel. A document of protest to the Premier was signed by many members. W.C.Woollard proposed that the FNCV executive take all possible steps to organise, with other similar bodies, a mass meeting to protest against the alienation of National Park land for a luxury hotel. Motion carried.

Field Naturalists Club of Victoria (1964). Geology Group meeting. 4 November 1964. **81**, 234.
Exhibits: Garnets in granite, tourmaline from Mt. Oberon.

Field Naturalists Club of Victoria (1965). Mammal Survey Group meeting. June 1965. **82**, 125-126.
Female Eastern Pygmy possum Cercartetus nanus, *reported nesting in a cupboard in April. Three young produced and the nest was vacated by 5 June.*

Field Naturalists Club of Victoria (1966). General meeting. 13 December 1965. **83**, 16-17.
F.L. Jeffs moved 'That the FNCV ask the Landscape Preservation Council to voice its disapproval to the Government at the granting of a licence to build a motel in Wilsons Promontory National Park'. Seconded by A.J. Swaby. Motion carried.

Field Naturalists Club of Victoria (1966). General meeting. 10 January 1966. **83**, 39.
No replies received to letters to the Premier concerning representation of natural history societies on the National Parks Authority; and to the Landscape Preservation Society concerning the motel.

Field Naturalists Club of Victoria (1971). Botany Group excursion to Wilson's Promontory, November 1970. **88**, 201-202.

Field Naturalists Club of Victoria (1974). Conservation Group: Report of the first meeting. **91**, 145.
J.R.Garnet reviewed the history of the FNCV in conservation.

Field Naturalists Club of Victoria (1974). Marine Biology and Entomology Group meeting. 3 March 1974. **91**, 149.
B.J. Smith gave an account of the Bass Strait dredging expedition in HMAS Kimbla. Dredging transects included Wilsons Promontory.

Field Naturalists Club of Victoria (1979). Excursion to Wilson's Promontory, Saturday, 1 November - Saturday, 8 November 1980. **96**, 207, 210, 251.
Details of the proposed Centenary excursion.

Field Naturalists Club of Victoria (1980). General meeting. 13 October 1980. **97**, 269.
Aspects of Wilsons Promontory presented by members of the Geology, Botany and Mammal Survey Groups.

Field Naturalists Club of Victoria (1981). General meeting. 8 December 1980. **98**, 46.
M. Turner showed slides of the Glennies, off the west coast of Wilsons Promontory, and talked about the native fauna there.

Field Naturalists Club of Victoria (1981). General meeting. 13 July 1981. **98**, 178.
Honorary membership presented to Ros Garnet. J.H. Willis referred to his book on Wilsons Promontory, and the fact that he was on the management committee for many years.

Field Naturalists Club of Victoria (1983). General meeting. 6 June 1983. **100**, 182.
Audio-visual cassette on Wilsons Promontory prepared by the Interpretation Section of the National Parks Service was shown.

Field Naturalists Club of Victoria (1984). Annual General Meeting. 14 May 1984. **101**, 141.
Conservation: M. Turner drew members' attention to the release of the joint draft zoning plan by the National Parks Service and Fisheries and Wildlife for the establishment of marine and wildlife reserves around Wilsons Promontory and Corner Inlet. Club submission to be made.

Field Naturalists Club of Victoria (1985). General meeting. 13 May 1985. **103**, 142.
Exhibit: Pumice found on a beach at Wilsons Promontory, which had originated 8000 miles away in the South Sandwich Islands as a result of a volcanic eruption in the 1960s.

Gabriel, C.J. (1934). *Thalassohelix translucens* found at Wilson's Promontory. In *Memoirs of the National Museum, Melbourne No 8, 1934.* **51**, 176.
Book review.

Galbraith, J. (1960). A Banksia Complex. **77**, 144-145.
Banksia spinulosa *on the Promontory.*

Garnet, J.R. (1954). V.N.P.A. excursion to Wilson's Promontory National Park. **71**, 110-113.

Garnet, J.R. (1970). The Wild Flowers of the Wilson's Promontory National Park. **87**, 375.
Book review. Advertisement. **87**, 342.

Garnet, J.R. (1980). National Parks and the FNCV. (illus.) **97**, 130-134.

George, G.G. (1960). Native Cats at Sealers Cove. **77**, 207.

Gomon, M. (1985). Review of The Freshwater and Estuarine Fishes of Wilsons Promontory, by P.D. Jackson and J.N. Davies. **102**, 42.

Gregory, J.B. (1885). To Wilson's Promontory Overland Part I. **2**, 43-48.

Gregory, J.B., and Lucas, A.H.S. (1885). To Wilson's Promontory Overland Part II. **2**, 54-59.

Gregory, J.B., and Lucas, A.H.S. (1885). To Wilson's Promontory Overland Part III. **2**, 87-90.

Gregory, J.B., and Lucas, A.H.S. (1886). To Wilson's Promontory Overland Part 4. **2**, 150-154.
Hall, T.S. (1905). Wilson's Promontory as a National Park. **21**, 128-131.
History of the reservation and the Club's involvement.
Hardy, A.D. (1906). Excursion to Wilson's Promontory: General. **22**, 191-197.
Hardy, A.D. (1906). Excursion to Wilson's Promontory: Botany. **22**, 212-223.
Hardy, A.D. (1909). Further Notes on the Flora of Wilson's Promontory. **25**, 170-171.
Paper read before the FNCV 8 February 1909. The author drew attention to difficulties of nomenclature, owing to changes. Professor Ewart promised to compile a list of alterations for publication in The Victorian Naturalist. Exhibit: Native Beech Fagus cunninghami *Hook., collected at Sealers' Cove. Text of paper. **25**, 195-200.*
Hill, S.M. (1994). Some Granite Landforms of Wilsons Promontory, Southern Victoria. (illus.) **111**, 184-190.
Hooke, A.G. (1959). The Gippsland Mallee. **76**, 212.
Eucalyptus kitsoniana *at Mt. Oberon.*
Hope, J.H., and Hope, G.S. (1970). Marsupials Caught in Pollen Traps at Wilson's Promontory. **87**, 270-271.
Howlett, D.C. (1964). Results of excursions in the 'Voluta' to Wilson's Promontory and to Westernport Bay. **81**, 202-205.
Dredging expeditions in a 20-foot boat .
Howlett, D.C. (1966). Excursion to Wilson's Promontory in 'Voluta'. (illus.) **83**, 193-196.
Jackson, P.D., and Davies, J.N. (1985). The Freshwater and Estuarine Fishes of Wilsons Promontory. **102**, 42.
Book review by M. Gomon.
Kenyon, A.S. (1906). Excursion to Wilson's Promontory: Ethnology. **22**, 223.
Kershaw, J.A. (1906). Excursion to Wilson's Promontory: General Zoology (except Mollusca). **22**, 197-207.
[Kershaw, J.A.] (1910). Request for living native fauna for introduction to Wilson's Promontory National Park. **27**, 35.
Kershaw, J.A. (1913). Excursion to the National Park, Wilson's Promontory: General and Zoology Report; Botanical Report, by A.J. Ewart, F. Pitcher, H.B. Williamson and J.W. Audas; Physiographical Notes, by A.J. Robertson. (illus.) **29**, 163-180.
Kershaw, J.A. (1915). Excursion to National Park, Wilson's Promontory. **31**, 143-152.
Kershaw, J.A. (1919). The National Park, Wilson's Promontory. **34**, 36.
Progress report: new tracks, introduction and establishment of native fauna, culling of koalas. Lack of funds had prevented the building of accommodation for tourists at Darby River, the erection of a bridge for vehicles, and the enclosure near the main entrance for displaying native fauna.
Kershaw, J.A. (1928). Notes on the National Park, Wilson's Promontory. **44**, 300-302.
Brief history, and notes on butterflies.
*Synopsis of the paper read before the FNCV 13 February 1928. **44**, 297.*
Kershaw, J.A. (1934). The Koala on Wilson's Promontory. (illus.) **51**, 76-77.
Kershaw, J.A. (1940). The Tiger Cat on Wilson's Promontory. **57**, 104-105.
Baron von Mueller recorded Dasyurus maculatus *at Wilsons Promontory in 1853, but it had not been seen since.*
Kershaw, J.A. (1941). The Platypus on Wilson's Promontory. **57**, 194-195.
Recent discovery of the platypus in Tidal River, Titania Creek and streams in Lillypilly Gully.
Three specimens of Tiger Cat (Dasyurus maculatus) *to be released on the Promontory.*
Latrobe Valley Field Naturalists Club (1973). Report 1972/73. **90**, 174.
Very successful boat trip to Refuge Cove in March.
Latrobe Valley Field Naturalists Club (1974). Report. **91**, 28.
Annual Club weekend at Wilsons Promontory in October, meeting with the Geelong Field Naturalists Club.
Leslie, J.R. (1925). Mosses of Wilson's Promontory. **42**, 116-117.
Lucas, A.H.S. (1888). Annual Conversazione: Address by the President. **5**, 3-4.
The desirability of the permanent reservation of Wilsons Promontory as a national park, and the steps to achieve this.
Lyndon, E. (1958). Notes on Wilson's Promontory, March 1957. **74**, 190.
Lyndon, E. (1977). The Golden Dodder Found in Wilson's Promontory. **94**, 264.
Lyndon, E. (1978). Range of Day Moths. **95**, 158.
Day moths of the family Agaristidae in swamps behind Biddy's Cove.
McQueen, R.H.J. (1960). Native Cats on Wilson's Promontory. **77**, 206-207.
Meagher, D. (1996). Review of Wilsons Promontory Marine and National Park, Victoria, by G. Wescott. **113**, 78.
Meagher, D. (1996). The Bryophyte Flora of Wilsons Promontory. (illus. map) **113**, 84-96.
National Parks Symposium. (1953). (illus.) **70**, 5.
P. Crosbie Morrison commented on uninformed criticism of the management of Wilsons Promontory, and urged support of the inauguration of the Victorian National Parks Authority.
Nethercote, G. (1920). A Girls' Camp at the National Park, (Wilson's Promontory). **36**, 126-131.
Tin prospecting observed in progress at Mt. Singapore.
Norman, F.I. (1988). Long-term Effects of

Rabbit Reduction on Rabbit Island, Wilson's Promontory. **105**, 136-141.

Norman, F.I., and Brown, R.S. (1979). A Note on the Vegetation of Citadel Island, Wilson's Promontory, Victoria. (map) **96**, 137-142.

Norman, F.I., Brown, R.S., and Deerson, D.M. (1980). The Flora and Avifauna of Dannevig, Norman and Wattle Islands, Wilson's Promontory, Victoria. (maps) **97**, 249-257.

Old Photos of Wilson's Promontory (1982). **99**, 185.
Appeal from the National Parks Service for photos up to the early 1950s for the new Information and Education Centre at Tidal River.

Offor, T. (1990). What Future for the Sandy Heaths of Wilson's Promontory? (illus.) **107**, 120-123.

One Hundred Years Ago (1988). Wilson's Promontory to Become a National Park? **105**, 16.
Extract from the Address by the President, A.H.S. Lucas. 5, 3-4.

Phillips, A.E. (1906). Notes on the Origin of the Names of Some of the Geographical Features at Wilson's Promontory, Corner Inlet, and Neighbourhood. **23**, 106-110.
Wilsons Promontory was named by Governor Hunter after Thomas Wilson, Esq. of London, who was a friend of Matthew Flinders.

Pritchard, G.B. (1906). Excursion to Wilson's Promontory: Conchology. **22**, 207-212.

Rayment, T. (1954). Mealy Bugs. **70**, 189.
Galls collected at Tidal River.

Salkin, A.I. (1981). A Short History of the Discovery and Naming of Banksias in Eastern Australia, Part IV. The Abbe Antonia Jose Cavanilles, Robert Brown, and Franz W. Sieber. **98**, 191-194.
Banksia cunninghamii *collected by D. Baxter 1825 at Wilsons Promontory, described by R. Brown.*

Salkin, A.I. (1981). A Short History of the Discovery and Naming of Banksias in Eastern Australia, Part V. Ferdinand Mueller. **98**, 254-256.
Mueller's collecting of banksias on Wilsons Promontory.

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The Wood and the Trees
A Muellerian Memoir of Wilsons Promontory
by the late Baron Ferdinand von Mueller (1825-96)

interpreted by Linden Gillbank[1]

Abstract
Mueller's botanical interest in Wilsons Promontory began with two trips in the 1850s. He collected botanical specimens for the herbarium and wood specimens for the international exhibition in Paris in 1855. He revisited the Prom in 1874 and in the 1880s he contributed to the FNCV's consideration of a national park there. *(The Victorian Naturalist* **115** (6), 1998, 286-291.

Dear readers,

It must be very difficult for you to imagine, let alone understand, attitudes and ideas that prevailed during my 19th century life - perhaps as difficult as it was for me to imagine how Wilsons Promontory would be perceived and enjoyed through the 20th century. Even toward the end of the 19th century, I could not imagine the changes in technology, lifestyle and ideas, that would allow a national park to endure on the Prom (an affectionate term I don't remember using). Despite the very real risk of your misinterpreting with 20th century wisdom my 19th century words, I would like them included in this commemorative issue of *The Victorian Naturalist.* So here, reconstituted from letters and reports, are some of my recollections of Wilsons Promontory - my 19th century words presented in a 20th century text.

Since this is the FNCV magazine, I shall start not at the beginning - my sea visits there in the 1850s - but towards the end of my story, with my participation in the 1880s in FNCV discussions about the reservation of Wilsons Promontory as a national park. By then a railway stretched eastwards from Melbourne to the tracks crisscrossing south Gippsland, making Wilsons Promontory accessible by land.

In August 1887 the FNCV secretary, F.G.A. Barnard, contacted me in my capacity as president of the Royal Geographical Society of Australasia, to elicit that society's support for FNCV efforts to convince the government to reserve Wilsons Promontory. I conveyed our support for 'reservations of areas with their pristine animal and plant' but not pastoral areas to Mr Barnard on September 1st. However, this was just as another area I had visited in the 1850s that was opened for selection - east Gippsland. Concerned that two east Gippsland plants, the Cabbage Tree Palm, *Livistona australis*, and the waratah, which I had named *Telopea oreades*, were in urgent need of protection I argued for the immediate reservation of valleys sheltering them. In February 1889, when the FNCV was engaged in convincing the government to reserve an area of Cabbage Tree Palms in east Gippsland, I advised Barnard against asking for a large reservation on Wilsons Promontory partly 'because the revenue would suffer'. I also pointed out that it was 'such a mild climate there, that many products, not hardy in Victoria, except in frostless places, could be reared there, the equable humidity being also advantageous for tillage there'. I added that in 1854 I had 'recognized, at Sealers cove the importance of many parts of Wilson's promontory for forest purposes, and as early as 1853 I found a cattle station to exist on the Western side of the peninsular' (Yanakie). In April 1890, unable to attend a FNCV meeting about the Prom, I informed Barnard that, in my opinion,

> 'we could not possibly induce the Government to cede so large an area … as the whole of Wilson's promontory; the distance from the metropolis would also be too great for the multitude of the people, to derive an adequate advantage from such reservations'.

I felt that our first priority should be to ensure that 'our most picturesque vallies', including those in east Gippsland, were not 'defaced and alienated from the crown'.

So, as you can see, towards the end of the

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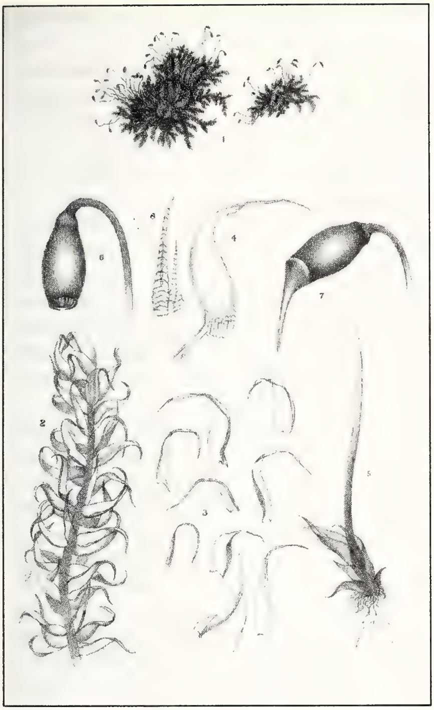

Fig. 1. *Hypnum callidioides* (current name *Sematophyllum amoenum*) collected at Sealers Cove. 1. Plant of natural size; 2. A branch, enlarged; 3. Stem-leaves, enlarged; 4. Perichætial leaf, enlarged; 5. Fruit-stalk, surrounded with perichætial leaves, enlarged; 6. Sporangium, without its operculum, enlarged; 7. Sporangium, with its operculum, enlarged; 8. Teeth of peristome, much enlarged. From 'Analytical Drawings of Australian Mosses,' ed. by Ferdinand Mueller, Government Printer, Melbourne, 1864.

19th century I had several doubts about the reservation of the whole promontory. I could not imagine the increase in the speed of travel and the proliferation of roads and rails that would bring the Prom so close to Melbourne and make it such a popular holiday destination, passionately loved by field naturalists and hikers. I believed that its climate made Wilsons Promontory too useful for agriculture, horticulture and forestry to be reserved solely to protect the indigenous flora and fauna, and, due to its distance from Melbourne, it would attract few recreational visitors. And what revenue would such a reserve provide the government? Well, that's how it seemed to me then. Of course I recognised the importance of reserves. At a scientific conference in 1890, I argued for the urgent and permanent reservation of areas of original vegetation to which 'indigenous plants and animals of exceptional rarity' could be transferred (Mueller 1890). The Prom's indigenous vegetation is interesting. I should know. I was the first person to document it. Let me explain how this happened. Within days of my appointment in January 1853 as Victoria's first government botanist, I set out on an extensive botanical expedition. I was keen to survey Victoria's flora and recorded indigenous plants of potential use and areas which I considered suitable for the cultivation of useful non-indigenous plants. In May 1853, many hundreds of miles and some months into my expedition, I was in Alberton, then the gateway to Gippsland. A short but sometimes precarious boat trip away was Wilsons Promontory, the southern-most part of Victoria and of the Australian continent.

Now I could survey Victoria's coastal flora and compare the flora of Wilsons Promontory with that of Van Diemen's Land (Tasmania) across Bass Strait. My timing was fortuitous. A decade earlier whalers sometimes sheltered in Sealers Cove and other eastern bays and a decade later (1863) there was no sawmill. But in 1853 Turnbull's sawmill at Sealers Cove was busy supplying building timber to Port Albert and Melbourne and even further afield (Lennon 1974).

From Alberton on 10th May 1853 I wrote to Lieutenant-Governor La Trobe and the colonial secretary, Mr Lonsdale, and arranged to send correspondence and specimens to Melbourne on the schooner *Meg Merrilies*. I explained to Lonsdale that 'having been once obliged to abandon the task, prevented by adverse wind and boisterous weather' I hoped 'to extend my researches over a part of Wilsons promontory, a locality for its most southern latitude in this continent [was] highly interesting'. And I acknowledged the great assistance of the Police Magistrate at Alberton in making the government boat available. I informed La Trobe that I would return to Melbourne 'as soon as my labours in the nearer parts of Wilsons promontory were finished.'

I reached Wilsons Promontory the next day. Dates on the relatively few of my specimens as yet included in the database at the National Herbarium, Melbourne, confirm that I collected plants and fungi on May 11th (near Mt Hunter), 12th, 13th and 26th (including Darby River). As I later explained to Lonsdale [27/6/53], several weeks were 'exclusively devoted for examining Wilson's promontory, in order to elucidate fully the connection, that exists between the Flora of this country and Van Diemen's land'. I was pleased that

> 'In the deep Ferntree-ravines of Sealers cov[e] I discovered for the first time in this continent the Tasmanian Beech tree (*Fagus Cunninghami*), ... closely allied to the Beechtree of Patagonia'.

However, I was disappointed in not finding 'any of the remarkable pines ... with which this useful tree in Van Diemens Land is consociated'. I did collect specimens of many other species previously unrecorded in Victoria and that certainly made my trip worthwhile.

So did the timber. I was so impressed with the diversity and quality of timber being milled at Sealers Cove, that I decided that samples should represent Victoria at the next international exhibition - to be held in Paris in 1855. I had to hurry. In the months between my arduous second and third Victorian expeditions, I prepared a list 'Specimens of 24 kinds of Native Wood from Sealer's Cove' for inclusion in the catalogue of the preliminary exhibition in Melbourne, sent a copy to the colonial secretary, John Foster, on 5th July 1854 and arranged to collect the specimens in August. On August 1st I wrote to Foster

> 'to solicit humbly the sanction of his Excellency the Governor for a voyage to Sealers cove at Wilsons Promontory, which tour I thought desirable for the purpose of obtaining a series of wood-specimens for the Paris Exhibition.
>
> I beg further to state, that the unconsiderable expenses, arising from this journey, will be defrayed out of the fund, which his Excellency has been pleased to sanction for the expenditure of the Commission.
>
> ... and I do not doubt, that on the mentioned interesting locality also other objects will offer themselves for botanical investigation'.

On 31st August 1854, I returned from Sealers Cove with two other passengers and a load of sawn timber on the brig *Xarifa* (Syme 1987) and informed Foster that transverse sections of 24 indigenous trees had 'been procured as specimens of our woods for the Paris exhibition'. Representing 'all the timber-trees of the district' they exhibited 'a considerable diversity of woods' and showed 'that here woods for any purpose may be obtained with the exception of such kinds perhaps, as are fit for ship masts'. I also brought back 'bark of the Sassafras tree, which forms a powerful substitute for the Peruvian bark' (a source of quinine), and many specimens of fungi and plants, including mosses and algae (Fig. 1). There were 'numerous specimens for the Governments herbarium, ... some seeds and living plants for the botanic gardens and several articles for the Melbourne Museum'. Melbourne's herbarium, botanic garden and museum all benefitted from my 1854 collecting trip.

In my annual report for 1854 I again stated that the samples I procured for the Paris exhibition provided 'additional proof that we possess woods here for any purpose, with the exception perhaps of such as are fit for the larger ships' masts' and wrote with enthusiasm about various Victorian timbers:

> The Blue Gum tree of Van Diemen's Land (*Eucalyptus globulus*) ... already so well known for its colossal size ... highly esteemed for ship building. ... The wood of *Callistemon salignus*, although seldom of considerable size, stands here, perhaps, unrivalled for hardness. ... The well-known Blackwood (*Acacia melanoxylon*) ... attains in the Fern-gullies an enormous size, and yields a splendid material for furniture, at once most substantial and capable of a high polish, being also recommended for the finishing work of vessels. The Myrtle tree of Sealer's Cove ... (*Acmena floribunda*) is also remarkable for its straight growth and its excellent wood. The Australian evergreen Beech (*Fagus Cunninghami*) forms a noble tree, sometimes more than 100 feet high,

of which the wood receives a beautiful polish. Omitting such kinds as are more generally known, I may mention as useful, chiefly for ornamental work, the Sassafras wood (from *Atherosperma moschatum*), the Lomatia wood (from *Lomatia polymorpha*), that of the Tolosa tree (*Pitosporum bicolor*), the Musk wood (from *Eurybia argophylla*), the Iron wood (from *Notolaea ligustrina*), that of the Oil-fruit tree (*Elaeocarpus cyaneus*), the Zieria wood (from *Zieria arborescens*), that of the Heath tree (*Monotoca elliptica*), and of the Australian mulberry tree (*Pseudomorus Australasica*) (Mueller 1854).

Later in my book *The Plants Indigenous to the Colony of Victoria* I noted:

'*Atherosperma moschatum* ... at Sealer's Cove a conspicuous feature in the forest, frequently consociated with fern-trees and *Fagus Cunninghami* ... A middle-sized tree, attaining, however, sometimes the height of 150 feet. ... The Native Sassafras must be regarded as one of the finest and most useful trees of this part of Australia. ... The powerful tonic property of its bark render the tree of high medicinal value, whilst its wood is less subject to bursting than most of the other indigenous timber; when polished it much resembles walnut-wood. ...

Pittosporum bicolor ... In the fern-tree gullies [of] Wilson's Promontory ... in favorable spots assumes a height of 40 feet ... .

Elaeocarpus cyaneus ... In the forest-gullies of Wilson's Promontory ... attaining ... in the damp glens of Sealers' Cove, a height of 60 feet' (Mueller 1862).

As a commissioner for L'Exposition Universelle which opened in Paris in May 1855, I orchestrated the exhibition of Victoria's botanical products in Melbourne and their subsequent transmission to France. *The Argus* of 25th October 1854 devoted many column inches to my exhibits, noting that my

'very valuable collection ... of indigenous woods must arrest the attention of even careless loungers in the building, notwithstanding the comparative remoteness and obscurity of the place they occupy.'

Table 1. List of wood specimens from Sealers Cove exhibited in the Melbourne Exhibition in 1854. Current names (Ross 1996) which differ from those I used are included in square brackets. # name suggested by Neville Walsh.

1. Blue Gum	*Eucalyptus globulus*
2. Flooded Gum	*Eucalyptus goniocalyx* [*E. cypellocarpa#*]
3. Myrtle	*Acmena floribunda* [*A. smithii*]
4. Stonewood	*Callistemon salignus* [*C. pallidus*]
5. Swamp Tea Tree	*Melaleuca squarrosa*
6. Oil Fruit	*Elaeocarpus cyaneus* [*E. reticulatus*]
7. Zieria	*Zieria arborescens*
8. Tolosa	*Pittosporum bicolor*
9. Blackwood	*Acacia melanoxylon*
10. Coast Acacia	*Acacia Sophorae* [*A. longifolia* var. *sophorae*]
11. Pomaderris	*Pomaderris apetala* [*P. aspera#*]
12. Prostanthera	*Prostanthera lasianthos*
13. Heath Tree	*Monotoca elliptica*
14. Ironwood	*Notelaea ligustrina*
15. Dogwood	*Bedfordia salicina* [*B. arborescens*]
16. Muskwood	*Eurybia argophylla* [*Olearia argophylla*]
17. Mulberry	*Pseudomorus Australasica* [*Hedycarya angustifolia*]
18. Australian Beech	*Fagus Cunninghamii* [*Nothofagus Cunninghamii*]
19. Coast Honeysuckle	*Banksia integrifolia*
20. Lomatia	*Lomatia polymorpha* [*L. fraseri*]
21. Australian Sassafras	*Atherosperma moschatum*
22. High Ferntree	*Alsophila australis* [*Cyathea australis*]
23. Common Ferntree	*Dicksonia antarctica*
24. Dwarf Ferntree	*Todea rivularis* [*T. barbara*]

Item 204 'Indigenous vegetable products' in the sometimes criticised *Official Catalogue of the Melbourne Exhibition 1854, in connexion with the Paris Exhibition 1855* includes my list of wood specimens from Sealers Cove, unfortunately with some spelling errors. Table 1 includes the common and scientific names I used. Note my inclusion of ferns as well as timber trees.

As I informed William Hooker on 22nd September 1854, I wanted our wood specimens exhibited in Paris to go to the Royal Botanic Gardens at Kew, England. Hooker's list of specimens in the Wood Museum at Kew includes my list of my Sealers Cove specimens - 'Victorian

Collection of Woods' in the archives of the Royal Botanic Gardens, Kew.

After returning from exploring northern Australia with Augustus Gregory, my government duties, but not my salary, were increased. In August 1857 I was appointed Director of the Botanic Garden. I had already sent John Walters to Sealers Cove to collect timber specimens and plants to grow in the botanic garden. In my report for 1857 I recorded that Walters was

> 'to obtain on a large scale ferns and young plants of the indigenous evergreen beech (*Fagus Cunninghami*), of the native Sassafras tree (*Atherosperma moschatum*), and of other trees and shrubs of that locality, either rare, useful, or ornamental'.

I explained that 'Through the aid kindly offered by the owners of the sawmill at Sealers' Cove' he was able

> 'to secure, besides a collection of timber specimens, a large number of young plants of forest trees, not only valuable as acquisitions to our Garden, but also for mutual interchange with similar institutions (Mueller 1857).

As before, I sent wood specimens to the museum, informing Professor McCoy on 1st August 1857 of the 'collection of 25 timber specimens, procured by Mr John Walters at Sealer's Cove under my order'. I also sent wood specimens and living plants to the Royal Botanic Gardens at Kew, informing William Hooker on August 10th that 'a collection of woods and of living plants' would be forwarded 'as soon as the former are dry and the latter established'.

By 1858 much of the timber accessible from Sealers Cove had been taken and the sawmill was closing. Turnbull's manager, William Buchanan, moved part of the tramway and plant across Corner Inlet for another mill (Lennon 1974), but, as I acknowledged in my annual and monthly reports, they continued to help me. I noted that during February 1858,

> 'the owners of the Sealers Cove sawmill have been generous enough to disclaim a debt of £15. 8/- incurred last winter by Mr Walters, when securing plants and timber specimens for this department at Sealers Cove'.

During March 1858 I was sent '9 Ferntrees from Sealers Cove by Messrs Turnbull', and during March 1859 'some large tree-ferns were kindfully contributed by Messrs Turnbull from Corner Inlet'. In my annual reports for 1858 and 1859 I included Buchanan and Turnbull in the long lists of donors of plants and seeds for the Botanic Garden (Mueller 1858b, 1860).

After my visits in the 1850s human activities and structures altered the Prom landscape. A lighthouse was built on the south-eastern point and later linked by telegraph to Foster and trigonometrical points were established on several peaks. My interest in the flora of Wilsons Promontory continued and in October 1874 I took the steamer to the lighthouse, and followed the telegraph track to Mt Oberon and other unbotanised areas. I was no longer Director of the Botanic Garden, but that's another story. A decade later three FNCV members walked to the lighthouse. I discussed my 1853 trip with them and helped determine the difficult specimens in their collections (Gregory and Lucas 1886). This brings me back to the beginning of this memoir, because it was they who in 1887 initiated FNCV efforts to establish a national park on The Prom - efforts which are discussed elsewhere in this volume.

My Prom collections did not generate as many new taxa as my collections on the Buffalo range at the beginning of my 1853 expedition. This is because, unlike the subalpine flora of the Buffalo plateau, much of the Prom's flora had been described from earlier collections in coastal Australia. Since most of the vascular plants I collected on the Prom had already been described, I could establish very few new taxa from my Prom specimens. Let me mention two. In my annual report for 1853 I mentioned *Thomasia petalocalyx* and *Pseudomorus Australasica* (Mueller 1853). I had already collected specimens of an undescribed *Thomasia* in South Australia and, on collecting specimens 'on coast rocks of Wilson's Promontory' in 1853, I described *Thomasia petalocalyx* (Mueller 1855). For the Australian mulberry I used the name *Pseudomorus Australasica* (e.g. in my list of wood specimens from Sealers Cove) before describing it but, after some consideration and correspondence, I acknowledged William Hooker's 'information on its correct generic position' and described *Hedycarya pseudomorus* (Mueller 1858a). Unfortunately for me,

Cunningham had already established *Hedycarya angustifolia* for the same species, which meant that my name was redundant. Thus, using Prom specimens I established a new species of *Thomasia* but not a new genus for the Australian mulberry.

As I have already mentioned, many of the plants I collected on the Prom had not previously been recorded for Victoria and I was very pleased to add many species to the flora of Victoria. In his species list of vascular plants Garnet (1971) includes Prom collections I mentioned in my *Fragmenta Phytographiae Australiae* and *Plants Indigenous to the Colony of Victoria.* Garnet (1971) includes specimens I collected in his lists of algae, mosses, liverworts, lichens and fungi recorded at the Prom. His list of 85 moss species includes 45 species collected by me. Soon the complete bryophyte collection in Melbourne's National Herbarium will be on its database and details of my Prom moss collections will be readily accessible.

In summary, my interest in Wilsons Promontory and its flora began with two visits there in the 1850s and endured for most of my long tenure as Government Botanist. My collections in 1853 and 1854 produced few new taxa of vascular plants but numerous new records for Victoria and also timber specimens for the 1855 Paris exhibition. I saw the Prom as having scientific, aesthetic and economic value. It was a site for productive pastoral and horticultural industry, and its indigenous flora was a source of taxonomic and phytogeographic information, herbarium specimens, garden plants, and timber. From my knowledge of Victoria's flora and of the patterns of Victorian settlement, in the 1880s I pressed for the prior reservation of areas other than the Prom. Now, at the end of the 20th century, I wish to congratulate the FNCV on its protracted (extending long after my death in 1896) but eventually successful efforts to have Wilsons Promontory reserved permanently as a national park, and hope that the 'richdom' of its indigenous vegetation will be protected in perpetuity.

Regardfully and posthumously your
Ferd. von Mueller

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An Early Overland Expedition to Wilsons Promontory

Sophie C. Ducker*

Abstract

That the Wilsons Promontory National Park is one of the first parks in Victoria to celebrate its hundredth birthday is due to the foresight and efforts of the early naturalists, among them one man: Arthur Henry Shakespeare Lucas. It is to Lucas, a biologist and science teacher, that I dedicate this article.(*The Victorian Naturalist* **115** (6), 1998, 292-295)

Arthur Lucas was born on 7 May 1853 at Stratford-on-Avon, England. His father, an itinerant Wesleyan clergyman, held poorly paid tenancies in different parts of England and Wales, but was keenly interested in the sciences, thus instilling in his young son a consciousness and love for the environment, so that Arthur started early to collect flowers and seaweeds, fossils and shells. With a scholarship, the boy spent seven years at a Wesleyan school under its iron discipline, Spartan conditions, no play, and no lessons in science. In 1870 he won a scholarship to Balliol College, Oxford, but because he was shy and poorly clad he was unable to participate in sports and other social life. In spite of all this he took Finals in Mathematics and Natural Sciences, and won the coveted Burdett Coutts Geology Scholarship, an open University prize that enabled him to pay his fees for a medical course. With further scholarships he won entrance to the London Hospital and also entered for the examination in botany set by the Apothecaries Society and open to all medical students. The examiner was the Reverend M.J. Berkeley, a great authority on fungi. Lucas won the Gold Medal; T.H. Huxley won only the Bronze Medal in his day.

Lucas sacrificed his medical career, however, to support the three children of his widowed brother by teaching mathematics and science at Leys School, Cambridge. It is here that he formed and conducted a Natural History Society, a first for him and the school. Science had begun to take its place in school curricula. When his brother Dr Thomas Pennington Lucas, having developed tuberculosis, was advised to migrate to Australia with his three children, Arthur Lucas followed seven years later to give support. He accepted the post of science and mathematics master at Wesley College in Melbourne. With his new bride, Charlotte Christmas, he sailed in the Orient steamer *Cuzco*, arriving at Williamstown on a hot January day in 1883 to take up his position as science teacher. The science laboratory at Wesley was a shed at the back of the school with a few test tubes and reagents. He introduced nature-study in the field, probably the first in Australia to do so. Taking an *ad eundem* degree[1], he became a member of the Melbourne University Senate. He was one of the advocates for establishing a separate chair of Biology, resulting in the appointment of another Oxford graduate, Baldwin Spencer, the first Professor of Biology.

Arthur's brother Dr T. P. Lucas had arrived with his new wife and three children in Melbourne in 1876 and had not only established a practice as a doctor but, being a dedicated naturalist, had founded, with others, The Field Naturalists' Club of Victoria in 1882. The proceedings so far had been published in the *Southern Science Record*, but from 1884 onwards the society published its own journal, *The Victorian Naturalist,* with Arthur Lucas as foundation editor until 1892. He was president from 1887 to 1889. There were other members of the Club whom he met early; indeed, on the first day of his arrival in Melbourne he visited Dr Ferdinand von Mueller, the government botanist[2]. Later on he met club members G.W. Robinson and J. Burslem Gregory. It was with these two that Lucas went in 1885 on a walking tour to Wilsons Promontory. At the time Gregory and Lucas reported the overland trip in three instalments of *The Victorian Naturalist*[3]. Nearly half a century later Lucas' student and friend Herbert Brookes[4] persuaded him, then an

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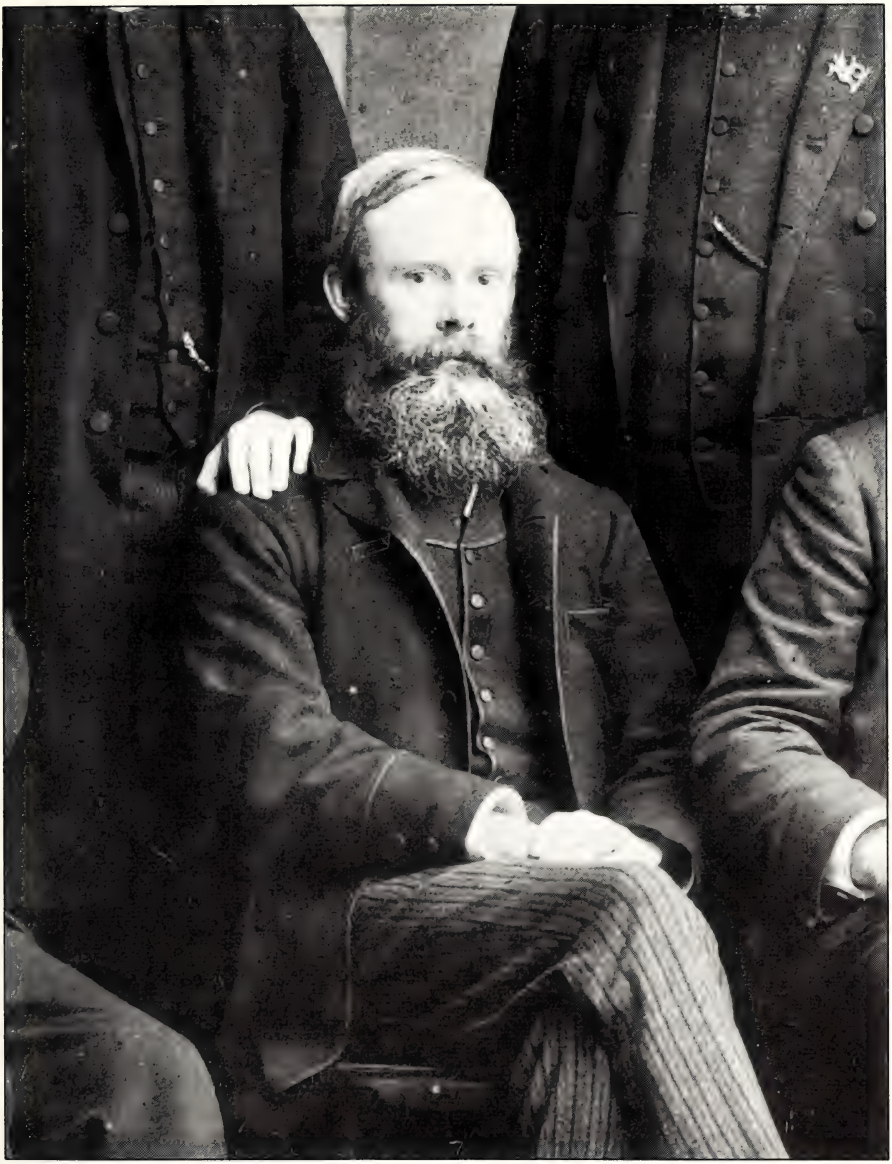

Fig. 1. Arthur Henry Shakespeare Lucas.

octogenarian, to write his memoirs, which were published posthumously[5]. I present here his recollections of the first overland trip of naturalists to Wilsons Promontory.

Amongst the members[6] was J. Burslem Gregory, a barrister, who spent a part of each summer vacation in making expeditions into some of the wilder parts of Victoria.

In January 1885 he invited me to join him in a walking trip to Wilson's Promontory. An old mountain pack-horse, kept by Gregory for the purpose, carried our tent, provisions and swags. I have never seen another horse which could and would walk along a log. We

started from a station on the Gippsland railway and walked south, crossing the Strzelecki Ranges among untouched fern gullies and virgin forest; crossed the neck of the peninsula through the Yanakie sheepstation, where we startled the grass parrakeets,[7] *and where Mr Miller, the manager, gave us a hospitable mutton feast; crossed the miles of rolling sand-dunes, where we might have been in Arabia; and so reached the west coast. Then down past the hills and estuaries to the lighthouse. Here we found sea asplenium*[8] *growing on the cliffs, and caught sundry leatherjackets, which we baked in the skins under the hot wood ashes.*

The lighthouse people were astonished to see us, and told us that they kept pigs to eat up the snakes which would otherwise have been a pest and a menace.

Retracing our steps in the peninsula we came to the estuary of the Tarwin, at a point where there was a horse ferry. It was late in the evening and we had trouble in routing out the ferryman, and found him decidedly the worse for liquor. We got aboard , the horse carrying his packs, and were ferried, as we thought, across the river, and the boat returned. But we soon discovered that the rascal had, by stupidity or malice , landed us on a low island. The tide was coming in fast. There was nothing to do but to attempt to wade across to the real bank.

Things went well at first, but presently the horse went down and we, up to our waists in water, had to haul him out, take off the packs, and proceed as best we could. We did eventually arrive on terra firma. To accentuate our plight it had come on to rain. We tramped soddenly along for a mile or so and then struck a shallow gully with piles of fallen timber. We managed to kindle a fire, and then piled on logs until we had a blaze big and hot enough to dry ourselves, and my soaked plant press, faster then the rain could wet us. Finally the rain ceased, and we were able to make a belated supper and a dry camp. The next two days we skirted the shores of Western Port and struck the railway again at Dandenong, after our two hundred miles' tramp, with precious little shoe leather on our feet.

Armed with vasculum and press I collected plants assiduously, and also a good many shells on the untrodden beaches. On our return the baron[9] *named the plants and Professor McCoy*[10] *the shells, and we read an account of our trip to the Field Naturalist' Club. The promontory had been in nowise*[11] *disturbed by settlement, and was entirely unoccupied. We suggested that the club should, in conjunction with the Royal Society, approach the Government and urge the reservation of the promontory as a refuge for the native fauna and flora. This was done, and to our joy the Government declared the whole of the promontory reserved for all time as a National Park.*

Lucas left Melbourne for Sydney in 1892 to take up a position as head master of Newington College, and then was Mathematical and Science Master of Sydney Grammar School for twenty-five years. Later he held relieving short posts at Sydney and Hobart Universities.

My interest in Lucas stems from the fact that his main interests, like mine, were marine algae. After retirement his energies were directed mainly towards the study of marine algae, holding an Honorary Curatorship of these at Sydney Herbarium. At the time his interests were not shared by other botanists in Australia, but travelling and collecting widely in Australia and some Pacific Islands he documented[12] some of the marine plants for the first time, and also in correspondence and exchange with overseas workers did much to further this study. He is, after the Irishman W. H. Harvey[13], the most important phycologist who dealt with Australian algae during the early part of the twentieth century. His travelling companion and helper in later years was Mrs George Perrin[14] who also published Part 2 of his *Seaweeds of South*

Australia.[15] He bequeathed his large collection of marine algae, about 6000 specimens, to the Commonwealth of Australia, and consequently it was housed by the Council for Scientific Research (CSIR) in Canberra. But with the present interest in marine algae, it was transferred to the National Herbarium of New South Wales, where it is a useful tool for botanists.

Lucas wrote, with W.H.D. Le Souëf, '*Birds of Australia*'[16] and '*Animals of Australia*'[17], and with Arthur Dendy '*An Introduction to the Study of Botany*'.[18] Like Mueller[19] he introduced the novelty of using Australian plants as examples in Australian schoolbooks.

Lucas was a member of the Council of the Linnean Society of New South Wales from 1894 until his death, serving as President from 1907-1909. In his Presidential address in 1908 he talked about what he believed to be the true relations between Science and Good Government.[20] He stressed that good government of the environment could only be achieved with informed and well trained people. Emphasising the need for knowledge on all fronts of the environment he states the example of the forests.

> *Australia has been lavishly endowed by nature with forests. These have been handed down to us intact by the simple-minded Aborigines.... Our immensely valuable forests have been recklessly devastated by fire and axe, by men regardless of all but immediate and personal returns. Here, again, the Government is confronted with a tremendous problem. We need living trees and much wood, and our children's children will need them no less than we.*

The same enthusiasm which drove the young schoolteacher in 1885 to walk to Wilsons Promontory, fired him twenty years later to call for good, scientifically informed government.

Endnotes

1 Admission to the same degree in another university.

2 (1825-1896), German born Victorian botanist, later with English and German titles Sir and Baron.

3 Gregory, J.B., and Lucas, A.H.S. (1886) To Wilsons Promontory Overland. *The Victorian Naturalist* **2**, 43-48, 54-59, 87-90.

4 Brookes, Herbert Robinson (1867-1963), pupil at Wesley, later businessman, philanthropist, active social and cultural seaside home in Point Lonsdale where Lucas worked on his algae and wrote his memoir.

5 Lucas, A.H.S. (1937). *A.H.S. Lucas, Scientist, His Own Story.* (Angus & Robertson Sydney).

6 members of the club.

7 sic.

8 *Asplenium obtusatum.*

9 Ferdinand von Mueller.

10 Sir Frederick McCoy (1817-1899), foundation Professor of Natural Science at Melbourne University.

11 ME, in no way or manner.

12 Lucas, A.H.S. (1936). *The Seaweeds of South Australia. Part 1. Introduction and the Green and Brown Seaweeds.* (Government Printer: Adelaide).

13 Harvey, W.H., (1811-1866), Professor of Botany at Dublin, he visited Australia 1854-56 and combining the results with his previous expertise, he wrote the first Australian algal flora *Phycologia australica*, (1858-63). (Lovell Reeve: London).

14 née Florence Dawson (1884-1952) from Launceston.

15 Lucas, A.H.S., and Perrin, F. (1947). *The Seaweeds of South Australia. Part 2. The Red Seaweeds.* (Government Printer: Adelaide).

16 Le Souëf, W.H.D., and Lucas, A.H.S. (1911). *The Birds of Australia.* (Whitcombe & Tombs: Melbourne).

17 Lucas, A.H.S., and Le Souëf W.H.D. (1909). *The animals of Australia: Mammals, Reptiles and Amphibians.* (Whitcombe & Tombs: Melbourne).

18 Dendy, A., and Lucas, A.H.S. (1892). *An Introduction to the Study of Botany.* (Melville, Mullen & Slade: Melbourne).

19 Mueller, F. (1877). *Introduction to Botanic Teachings at the Schools of Victoria.* (Government Printer: Melbourne).

20 Lucas, A.H.S. (1908). Presidential Address, *Proceedings of the Linnean Society of New South Wales* **33**, 1-38.

The Scientific Importance of Wilsons Promontory

Geoff Wescott[1]

Abstract
Wilsons Promontory is a scenically beautiful area which is also full of scientific interest for both terrestrial and marine environmental enthusiasts. This short article describes just some of these significant scientific features. (*The Victorian Naturalist*, 1998, **115** (6), 296-299).

Wilsons Promontory, 'the Prom', is best known and most loved because of its beauty, its ruggedness and its accessible flora and fauna rather than for its interest to science. Yet this triangular shaped promontory jutting out into the wild waters of eastern Bass Strait is of significant scientific importance as well. This brief article, that commemorates the centenary of declaration as a national park, will discuss some of these points of scientific interest, taking a roughly chronological sequence for inspiration.

The Prom's physical attributes and history

The Prom is based on granite formed over 380 million years ago, with most of the current land forms having been created against this granite backdrop in the last 120 000 years through various sea level, and consequent depositional, changes. These changes make the Prom an excellent 'text book' for the study of geological and geomorphological change.

The sea was six metres higher 120 000 years ago, and the Prom would then have been a series of islands with none of the low-lying areas above the sea (e.g. the Yanakie Isthmus, the Tidal River valley). As the sea level dropped the isthmus (known geomorphologically as a 'tombolo') would have formed joining the granite 'islands' to the mainland. But even the isthmus has been changed often - being more substantial than at present on at least four occasions when the sea level was lower than today.

The most important of these levels was 18 000 years ago when the sea level was 130 m lower. In scientific terms this was a critical period for the flora and fauna as it was the last occasion on which the mainland of Australia was joined to Tasmania.

This allowed humans to move between Victoria and Tasmania taking with them, intentionally and unintentionally, a range of floral and faunal species, 'mixing' the distinctive mainland and Tasmanian floras and faunas. As well, the natural movement of plant pollen and seeds and animal dispersal would have been substantial leading to the distinctive mainland/Tasmanian 'mix' of species at the Prom (and in the Otways).

A lesser known but equally important ramification of this land bridge was that it 'blocked' the movement of the planktonic larvae of marine species, isolating eastern coast species from their previous 'neighbours' and closely aligned species of the western (and southern) seas. Although these marine evolutionary relationships have not been as closely studied as the terrestrial ones the presence of a distinctive southern Victorian and Tasmanian range of marine species, (e.g. shore crabs *Cyclograpsus audouini* and *C. granulosus* crabs; Dartnall 1974) and the Prom as a partial barrier, or border, between the eastern and southern floral and faunal assemblages of marine species, is of significant interest and deserving of much greater study.

The Prom's floral attributes

As described above, the Prom is the terrestrial 'meeting ground' for a range of species from southern cool temperate Tasmania, from the eastern subtropical coast and from warmer northern and western Victoria. The isthmus has also been apparently an effective barrier for some species (e.g. Silver Wattle *Acacia dealbata*) which have reinvaded from the north, and other Tasmanian species coming from the south, e.g. Bushy Peppercress *Lepidium desvauxii*, Cherry Rice-flower *Pimelea drupacea* (Smith 1978).

One of the most interesting species is the stunted white mangrove tree *Avicennia marina* at Miller's Landing, the southernmost limit of mangroves in Australia, and probably the world (Back Cover F). Probably the most fascinating plant

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community is the occurrence of subtropical rainforest species, such as Lilly Pilly *Acmena smithii* - it is even more bizarre given the presence of cool temperate rainforest species, e.g. Myrtle Beech *Nothophagus cunninghamii* within a few kilometres (Smith 1978).

Overall, as well as nearly 40 curious or significant terrestrial plant species (Wescott 1995, Appendix 1) there is a total of 668 native and 103 introduced plant species at the Prom, including 30 species of native grasses, 49 sedge species, 76 orchid species, 59 fern species and, not to be forgotten, 90 species of mosses, at least 50 species of liverworts and many fungi and lichen species.

The marine environment also contributes significantly to the Prom's floral attributes, with a substantial range of habitats including significant saltmarshes and mud flats in Corner Inlet and Sandy Inlet.

The Prom's faunal attributes

In some ways it is the absence of certain animal species, which you might expect to find given the plant communities of the Prom, that is the feature of the terrestrial mammals at least.

There are no large glider species, and the Platypus *Ornithorhynchus anatinus*, Tiger Quoll (Spotted-tailed Quoll) *Dasyurus maculatus*, Eastern Quoll *Dasyurus viverrinus*, Dingo *Canis lupis dingo* and Red-necked Pademelon *Thylogale thetis* are absent.

A curious feature of ongoing discussion and debate is the relative numbers of wallabies and kangaroos on the Prom, both now and in the past. There is a belief that kangaroos were not particularly prevalent on the Prom in pre-European times but that grazing, fires and other activities have led to a proliferation of open grasslands in the north which has in turn led to a rapid increase in kangaroo numbers - a problem for the future management of the Prom. In turn wallaby numbers have probably dropped substantially as kangaroo numbers have increased, but these phenomena are yet to be studied scientifically.

Even more curious though, has been the series of 'introductions' of native, but not necessarily 'endemic', animals to the Prom since its declaration as a national park. Between 1900 and 1941 at least 21 species were introduced (Land Conservation Council 1980, Appendix 2), including a range of kangaroo, wallaby, possum, glider and bandicoot species. Probably only two - the Eastern Grey Kangaroo (Pl. 4H) and the Koala (Pl. 4G) - are still present. What an irony - two of the most 'loved' species by the casual visitor to the Prom may well be 'introduced'!

The reasons for these introductions are not clear but are probably related to the 'acclimatisation' societies of the last century, which introduced non-native species to the western half of the state.

About half of all bird species in Victoria are found on the Prom (230 species) and the proximity of mountains to the sea means there is a great mixture of species, ranging from those usually found in inland areas to predominantly marine species.

Nineteen of the 40 native species of Victorian freshwater fish are also found in the streams of the Prom along with 18 other species. The Prom is a vital area for the conservation of these native species - which begs the question as to why the killing of these native vertebrate species (ie. fishing) is allowed in a national park of such significance?

The Prom's marine species and communities

Unfortunately for most visitors to the Prom, the land species are regarded as scientifically interesting and worthy of protection whilst the sea is seen just as part of the beautiful vista. The marine environment around the Prom is also fascinating and, with further study, will probably prove even more scientifically interesting than the land. We need to ensure that in the second century of this park, more attention is paid to the study of the sea environment than was done in the first century - this is just one of the scientific challenges which the Prom represents.

Conclusion

The Prom is seen by many Victorians - aboriginal and non-aboriginal - as a magical and mystical place, and so it is. For a scientist or naturalist one of the challenges of the Prom is to learn more about its ecological processes to aid better management whilst never losing that mystical wonder for this soulful place.

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Appendix 1. Significant Plant Species at Wilsons Promontory

Common name Species name	Reason for significance
1. Species rare in Victoria	
Club Moss, Long/Tall *Huperzia varia* (Pl. 3A)	Rare fern of Closed Forest
Wedge-fern, Oval *Lindsaea trichomanoides* (Pl. 3B)	Rare fern of Closed Forest
Crimson Berry *Cyathodes juniperina var. oxycedrus* (Pl. 3D)	Tasmanian species also at Cape Woolamai, Phillip Island
Daisy Bush, Promontory *Olearia allenderae*# (Pl. 3C)	Shrub of swampy heath, endemic to Gippsland
Fern, Jungle/Large Bristle *Macroglena caudata*	Rare fern of Closed Forest
Messmate Stringybark *Eucalyptus obliqua var. discocarpa*	Tasmanian species
Nettle, Smooth/Shade *Australina pusilla*	Tasmanian and NSW species
Pepper-cress, Bushy *Lepidium desvauxii*	Coastal herb
Pondweed, Thin *Potamogeton australiensis*	Rare
Prickly Moses *Acacia verticillata var. latifolia*	Tasmanian variety, only other Victorian record is from Sunday Island
Rice-flower, Cherry *Pimelea drupacea*	Tasmanian species
Rice-grass, Pointed *Tetrarrhena acuminata*	Grass of damp gullies
Spider-orchid, Narrow-lip *Caladenia leptochila*	Only a few collected in Victoria
Spleenwort, Shore *Asplenium obtusatum*	Restricted to rocky coastlines; a large form of the species (once given specific rank as *A. scleroprium*) occurs at the Prom
2. Species with disjunct (broken) distributions or at the limit of their geographic range	
Ballart, Coast *Exocarpos syrticola*	Eastern limit
Banksia, Saw *Banksia serrata*	Western limit
Bent-grass *Deyeuxia benthamiana* = *D. scaberula*	Grass of Eastern Highlands
Bog Gum *Eucalyptus kitsoniana*	Eastern limit
Bog-rush *Schoenus carsei*	Also in SW Victoria
Bog-rush, Matted *Schoenus breviculmis*	Sedge of the Mallee
Bossiaea, Variable *Bossiaea heterophylla*	Western limit
Brake, Netted *Pteris comans*	Eastern limit
Fern, Fragrant *Microsorium scandens*	Western limit
Fescue, Hooker's *Festuca hookeriana* = *Astrogestuca hookeriana*	Grass of Eastern Highlands & SW Victoria
Greenhood, Banded *Pterostylis vittata*	Eastern limit
Ground-berry, Ridged *Acrotriche affinis*	Eastern limit
Kunzea, White *Kunzea ambigua*	Western limit
Lilly-Pilly *Acmena smithii*	Western limit
Mangrove, Grey *Avicennia marina*	Southern limit
Oliveberry, Blue *Elaeocarpus reticulatus*	Western limit
Paper-flower *Thomasia petalocalyx*	Eastern limit
Purple-flag, Leafy *Patersonia glabrata*	Western limit

Appendix 1 continued.

Common name Species name	Reason for significance
Rabbit's Ears/Vanilla Orchid *Thelymitra antennifera*	Species of Western Victoria
Sea-wrack *Halophila ovalis*	Corner Inlet is eastern limit of known range
Sun-orchid, Blotched *T. fusco-lutea*	Species of Western Victoria
Stringybark, Yellow *E. muelleriana*	Western limit

Appendix 2. Known liberations of native mammals at Wilsons Promontory

Common name Species name	Year(s)	Number
Bandicoot, Eastern Barred *Perameles gunnii*	1923	Unknown
Bandicoot, Long-nosed *Perameles nasuta*	1911-23	Six
Bobuck (Mountain Brushtail Possum) *Trichosurus caninus*	Unknown	
Cat, Tiger (Spotted-tailed Quoll) *Dasyurus maculatus*	1941	Unknown
Dunnart, Fat-tailed *Sminthopsis crassicaudata*	1933	Unknown
Echidna *Tachyglossus aculeatus*	1911	Several
Euro (Eastern Wallaroo; a kangaroo) *Macropus robustus robustus*	pre-1914	unknown number
Glider, Greater *Petauroides volans*	1929, 1934	One each year
Glider, Sugar *Petaurus breviceps*	1934	Four
Kangaroo, Eastern Grey *Macropus gigantus* [a]	1910-12	Several
Kangaroo, Red *Macropus rufus*	1914	Three
Koala *Phascolarctus cinereus*	Various years	
Pademelon, Red-bellied *Thylogale billardierii*	1911-14	Several
Possum, Tasmanian Brushtail *Trichosurus vulpecula fuliginosus*	1911-14	Several
Pygmy-possum, Western *Cercartetus concinnus*	1934	Unknown
Rat-kangaroo, Rufous (Rufous Bettong) *Aepyprymnus rufescens*	1923	Two
Tree-kangaroo, Bennetts *Dendrolagus bennettianus*	Unknown	
Wallaby, Black-striped *Macropus dorsalis*	pre-1914	Several
Wallaby, Brush-tailed Rock *Petrogale penicillata*	pre-1915	Several
Wallaby, Northern Nailtail *Onychogalea unguifera*	1924	Two
Wallaby, Red-necked *Macropus rufogriseus*	1911-14	Several
Wombat (including King Island Wombat) *Vombatus ursinus*	1910	Several

[a] There is a view that the Eastern Grey Kangaroo, which is now very numerous in the park, was not present last century. This is based on the lack of mention of kangaroos (as distinct from wallabies) in early naturalists' reports.

Promontory Daisy Bush *Olearia allenderae*

This plant was described by J.H. Willis from the specimen found by Marie Allender at Wilsons Promontory on 27 October 1964, and he named it after her (Plate 3C). Marie was an active member of the FNCV and was made an Honorary Member for her work as Excursion Secretary for over 30 years. As Dan McInnes said in her obituary 'The name of Allender will live forever in the name of a plant, ***Olearia Allenderae*** **J.H. Willis spec. nov.**, found only in a small tract of land on Wilsons Promontory. Dr J.H. Willis wrote that he had pleasure in naming this graceful plant after its discoverer, Miss Marie Allender (of the Melbourne Herbarium staff) who has advanced our knowledge of the Victorian flora by several other noteworthy discoveries'. (*The Victorian Naturalist* **112** (1995), 267).

HOLOTYPE: Wilson's Promontory, S. Victoria, in swampy depression ± 2 miles north of Darby River crossing – Marie Allender, 27 Oct 1964 (MEL). *ISOTYPES* at MEL, NSW, AD, K.
PARATYPE: Ibidem – Marie Allender 24 Oct. 1961 (MEL).

A slender shrub, sparingly branched, 1–2 m high, with elongated, leafy, purplish, costate branches that push up through dense paludal shrubberies.(J.H. Willis, 1967, *Muelleria* 1^3:156).

Editors

The Geology of Wilsons Promontory

Gary Wallis[1]

Abstract
The Devonian age Wilsons Promontory granites occur as a complex, differentiated batholith. Intrusive features are readily observed and include flow concentrations of dark enclaves, feldspar megacrysts, garnet and biotite. Tourmaline is widespread in the more felsic granites and a small amount of cassiterite was mined in the north-east of the outcrops. No associated volcanic rocks occur, but gas cavities indicate shallow emplacement depth of magma that originated from partial melting of sedimentary crustal rock. Silica-rich and lime-rich sands were deposited on the lower slopes of the eroded batholith during the sea-level changes of the Pleistocene ice ages. By the time of the last sea-level rise, sand accumulation formed an isthmus that joined the granite island to the mainland, thus forming the Promontory. *(The Victorian Naturalist* **115** (6), 1998, 300-306).

Introduction

Wilsons Promontory is a peninsula consisting of a rugged mountain chain of Devonian granites, which rises over 750 m above sea level and is flanked in places by Quaternary sand dunes and swamp deposits. It is a former granite island, which is now joined to the mainland by the broad sand accumulation of the Yanakie Isthmus. Spectacular rock exposures (Back Cover G), especially along the coastline, enable a study to be made of a complex-differentiated granitic pluton. Dune sand sequences, which formed during the glacially influenced sea level changes of the Pleistocene, now dissected by current sea levels, are easily viewed on the Promontory's west coast. Detailed geological field guides to Wilsons Promontory (Wallis 1988) and to the Tidal River area (Wallis 1989) have been published elsewhere. This article aims to provide Naturalists with a summary of the geology of this magnificent natural heritage area.

Visitors to Wilsons Promontory have from the beginning valued its diverse scenery and contrasting ecosystems. These contrasts are largely controlled by geological factors. Broadly, the Promontory is divided by a central mountain chain running north-north-west whose shape has been determined by structures within the original granite mass, subsequent faulting and deep weathering and erosion of the batholith. Broad sandy beaches that only occur where protective granite spurs protrude into the sea break the rugged coastline. Sand dunes behind the beaches have delayed stream entry to the sea and extensive river flats and swamps occur. Over a dozen granite islands occurring off-shore from Wilsons Promontory are the result of coastal submergence since the end of the last ice-age some 18 000 years ago. The myriad of ecological niches created in this structurally complex mass has resulted in the biodiversity for which the 'Prom.' is well known.

Geological investigations have been few, considering the popularity of the area for scientific research in other disciplines. This may be in part due to the old belief that granite masses were largely homogeneous bodies of rock consisting of simple mineralogy. The opposite is true, but it is only 25 years ago that some of the intrusive features and two of the major granite types were recognised (Worboys 1973). Only two major geological studies have been undertaken in this National Park, 'The Coastal Geomorphology of Wilsons Promontory' (Tuddenham 1970) and 'The Geology of the Wilsons Promontory Batholith' (Wallis 1981).

Geological Setting

Wilsons Promontory lies to the east of one of the most important structural lines in Victoria, the Waratah Bay axis. A Cambrian greenstone sequence occurs intermittently along this axis on up-faulted zones, one section forming part of the western coast of Waratah Bay opposite Wilsons Promontory. Undifferentiated Ordovician rocks are exposed on the immediate north of the Promontory.

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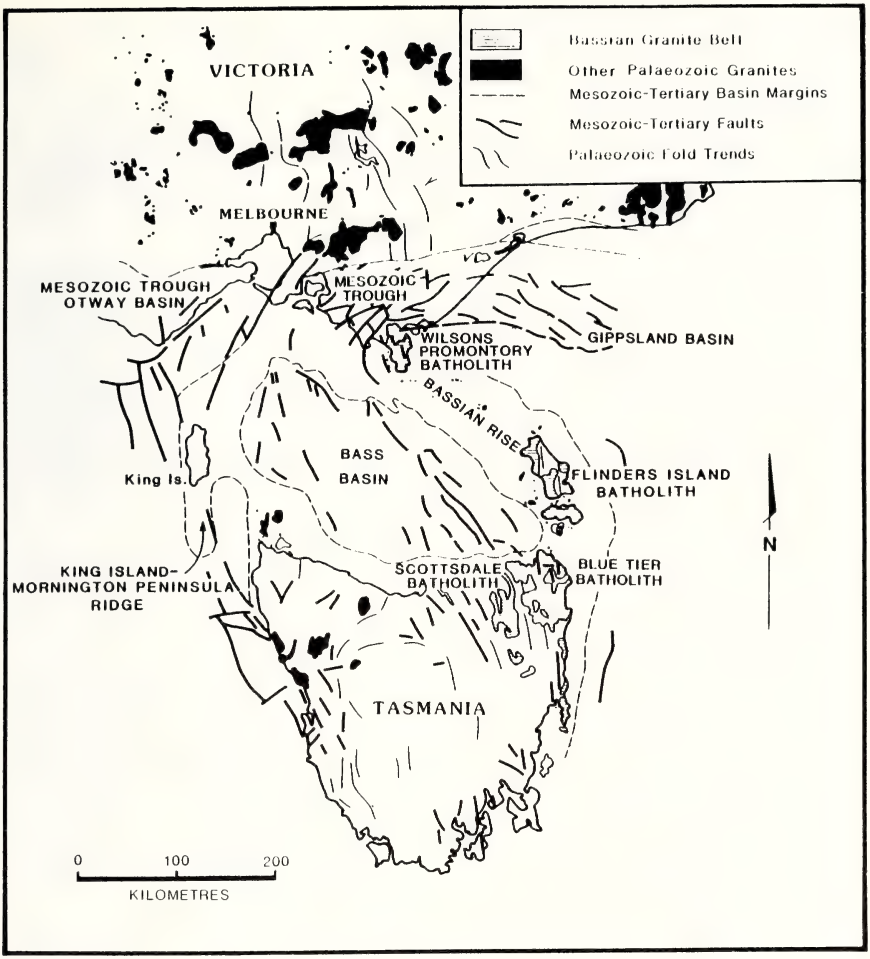

Fig. 1. Distribution of granite and sedimentary basins in Victoria and Tasmania.

The axis formed the eastern margin to the Melbourne Trough. Some of the youngest Palaeozoic marine rocks in Victoria developed along this former shoreline. There are Early Devonian limestones between Walkerville and Point Grinder on the western side of Waratah Bay, and immediately to the west, separated by a strike fault, there are the deeper water sedimentary rocks of the Liptrap Formation of similar age.

Bedrock throughout Wilsons Promontory is composed of a strongly differentiated granitic pluton, apart from the batholith intrusion into a small area of probable Ordovician sediments at Red Bluff, near Yanakie. No associated volcanic rocks have been found but evidence of cavities in the granites indicates its high level of emplacement (less than 5 km down) in the Earth's crust. The Wilsons Promontory Granite has been dated by the Potassium-Argon technique at 379 million years and is closely related to granites in northeastern Tasmania, both in chemical composition and age (Richards and Singleton 1981). It belongs to the Bassian basement terrain of the Lachlan Fold Belt (Stump *et al.* 1986). By contrast, the nearest batholiths of Central Victoria are mostly 365–370 million years old. The Wilsons Promontory Granites intruded during a mountain building event known as the Tabberabberan Orogeny

Fig. 2. A typical tourmaline nodule in the granite. Note the pale rim where biotite has been dissolved to crystallise the tourmaline. Lighthouse Track, Mount Oberon.

while the Central Victorian granites postdate this tectonic phase.

Following the uplift of the Tabberabberan Orogeny, the region was subjected to a long period of erosion until the Late Mesozoic era. During the Early Cretaceous, when Australia was drifting away from Antarctica, related east-west grabens developed, in which fluviatile sediments were deposited in southwestern and southeastern Victoria. This was the Age of Reptiles and significant fossils of 'polar dinosaurs' are being discovered within these freshwater sedimentary rocks along the coast to the west of Inverloch. Subsequent strong block faulting led to the formation of two Tertiary basins of deposition, namely the Bass Basin, southwest of Wilsons Promontory, and the Gippsland Basin to the east. Major deposits of brown coal, oil and natural gas originate in the Gippsland basin.

In late Cainozoic times, changes of sea level took place, which submerged parts of the Wilsons Promontory Batholith to varying depths. Contrasting quartz-rich and calcium carbonate (lime)-rich sands found on present day beaches were formed during these changes of sea level.

Wilsons Promontory Batholith

The granites of Wilsons Promontory are the northern end of a granite belt which is almost 500 km long and about 50 km wide. The belt extends into north-eastern Tasmania and along its east coast (Fig. 1).

The granitic mass can be described generally as grey, coarse-grained, biotite granite. Within this mass over seven major varieties of granite, with distinctive textures and mineralogical differences, can be mapped on the Promontory and its surrounding islands. The different granites are sheet structures of 10 m to over 100 m thick. They commonly have shallow easterly dips and outcrop largely as parallel zones. Four essential minerals are always present, although varying in relative amounts between these different granites.

1. *Biotite* or black mica occurs as thin crystalline flakes.
2. *Quartz* is often grey coloured, coarse (over 1 cm) and rounded in section. This unusual shape of quartz (bipyramidal B habit) is due to its high temperature crystallization in the cooling granite.

White feldspar is of two main types, i.e

3. *Plagioclase* (Andesine-Oligoclase); and
4. *Orthoclase* which often forms giant rectangular shaped crystals about 5 cm long.

Important accessory minerals occurring in the granites are pink *Garnet*, blue-grey *Cordierite*, and black *Tourmaline*. The cordierite has often been altered to a green mica. Tourmaline is a mineral which occurs in a number of forms within the granites, particularly the light-coloured granites.

All through the Promontory thin black tourmaline veins, usually with several subparallel to each other, can be seen cutting the granite (e.g. north end of Norman Beach). Tourmaline also occurs as nodules (Fig. 2), as crystals in cavities, and as replacement of earlier feldspars in granites and aplites. In rare dykes of pegmatite it has been found as crystals up to half a metre in length. Associated with tourmaline in the north-eastern portion of Wilsons

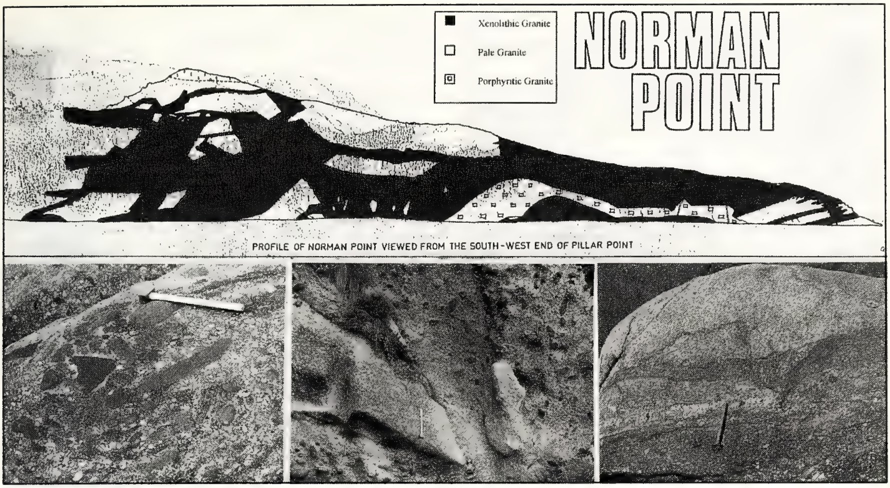

Fig. 3. Some intrusive features seen near granitic contacts in the Wilsons Promontory Batholith. Norman Point. (a) curved flow feature of enclaves, mica, garnet and feldspar megacrysts, South Norman Beach; (b) pale granite intruded by enclave-rich granite, Norman Point; (c) interflow 'mingling' of pale granite and enclave-rich granites, Western end, Norman Point.

Promontory tin mineralization occurs in the form of cassiterite, an oxide of tin, which is its main ore.

Between 1920 and 1936 about 200 kg of cassiterite was mined from hillside gravels on the Mt Hunter-Singapore saddle area (McKellar 1993). More recently, in 1967, extensions of these tin deposits were prospected for in Corner Inlet, where a drill hole near Bennison Island penetrated over 100 m of marine sands and clays without encountering the expected granite gravels (Couper 1968).

The minerals in the granite are the result of crystals growing in a liquid rock as it began to cool within the earth's crust. As it slowly moved up towards the surface it cooled completely and became solid rock. Many clearly observable features at Wilsons Promontory show how later granites have forced their way through earlier rocks as a crystal mush, to form this huge granite complex. Such features are particularly well exposed at the southern end of Norman Beach and on Norman Point, but are wide spread along the west coast (Fig. 3).

Enclaves are inclusions in the granite. (Pl. 4B) They used to be termed xenoliths but the term enclave is preferred as it does not have the genetic implication of an origin as 'foreign stones'. Enclaves are the common dark rounded patches within the grey granite. The enclaves are an integral part of this batholith and highlight its flow, as do the large white orthoclase crystals. Recent research has shown that some of these enclaves may originate from magma mingling (Elburg and Nicholls 1995) while others originate with the granite liquid at a zone of melting deep within the earth's crust. The Wilsons Promontory granites result from the partial melting of sedimentary rocks. Locally, enclaves have been concentrated into a rock looking somewhat like plum-pudding. Well exposed examples of these enclave concentrations are to be seen at the southern end of Norman Bay beach.

Within the coarse granites finer grained microgranites and aplites occur as gradational layers and thick dykes. These finer grained rocks are more common to the east. At South-East Point, below the Lighthouse, is a flat-lying dyke of fine-grained grey granite from which the Lighthouse was built in 1859.

During, and subsequent to, their cooling the Wilsons Promontory granites were subjected to regional stress which resulted in fracturing and rock movement. Faults produced by these movements are mostly near vertical. The present shape of the promontory is a consequence of these lines of faulting as well as the smaller scale

Fig. 4. Wind-blown Pleistocene sands (calcarenites) resting on the granites have slumped due to marine erosion. View of Darby Bay from Tongue Point walking track.

cooling joints in the granites. Erosion along fault lines controls many valleys such as Lilly Pilly Gully and the upper reaches of Tidal River. Norman Island is almost divided in two by erosion of a 200 m-wide zone of east-west faulting.

The Promontory granites have been exposed as a result of the removal of thousands of metres of overburden. Today the eroded granite is often seen as large rounded boulders called tors (Back Cover H). Their origin is due to the regular joint pattern. The joints tend to be at right angles to each other producing large approximately square blocks of granite. Water seeping along these joints decomposes the granite to clays and gravel. Tors are the rounded core stones left after weathering of these joint blocks. Tors dot the hillsides, particularly along the Boulder Range and many majestic examples can be seen near the saddle on the Waterloo Bay track. Weathering depths of 300 m have been interpreted within the batholith (Hill and Joyce 1995). Wind erosion has further sculptured the tors.

Marine erosion has carved sea caves into the jointed granite. Such caves occur on both the east and west sides of the Promontory and its offshore islands. On Great Glennie Island a 25 m deep cave occurs, even behind the beach in the sheltered cove. On the same island, a large gully on the north-eastern side results from collapse of the weathered roof of a sea cave. Cleft Island ('Skull Rock') has a spectacular example of cave development. The top cave is over 20 m above sea level with a 60 m high roof. Its origin most likely relates to higher sea levels of the past.

Quaternary Sediments

Overlying the granites are four main phases of sand dune formation, peat deposits, and Recent beach sands. All have been controlled by major sea level changes during Pleistocene ice ages.

Wilsons Promontory forms an important dividing line between two main sand types in southern Australia. The west-east contrast is between yellow lime-rich (over 30% carbonate) sands to the west and white silica-rich (less than 5% carbonate) sands to the east as illustrated by the beaches of Oberon and Waterloo Bays.

Studies have shown that during an earlier interglacial 100 000 years ago, when Wilsons Promontory was an island, the white silica sands drifted across what is now Corner Inlet and the Yanakie Isthmus and down the west coast (Tuddenham 1970). These sands are usually inland of the present yellow beach and dune sands, such as occur at Norman Bay. Squeaky Beach is a notable exception as here the foredune backing the beach is white silica sand of well-rounded and even sized grains. The beach originates from erosion of the dune, but at the water's edge an inter-fingering of recent yellow sands coming from offshore can be seen. If the dry silica sands are walked on, they will 'squeak', as the grains rub together (Beasley 1972).

Calcarenites, wind blown dune sands that are cemented by lime dissolved from shell fragments, form vertical cliffs at Darby Bay (Fig. 4, Pl. 2D). Remains of wood taken from a fossil soil horizon in the calcarenites have been dated at greater than 40 000 years (Coutts 1970). Off-shore at Darby Bay these rocks extend to Shellback Island, and down to depths of at least 20 m below sea level, where a submerged cliffline records a marine stillstand. This evidence of lower sea levels coincides with data elsewhere in the Bass Strait region that suggests sea levels dropped between 55 m and 180 m during the last glacial maximum (Fig. 5). At that time Wilsons Promontory was a part of the land bridge with Tasmania. The earlier silica sand movement from the east was halted against the east side of the promontory and lime-rich sand began accumulating

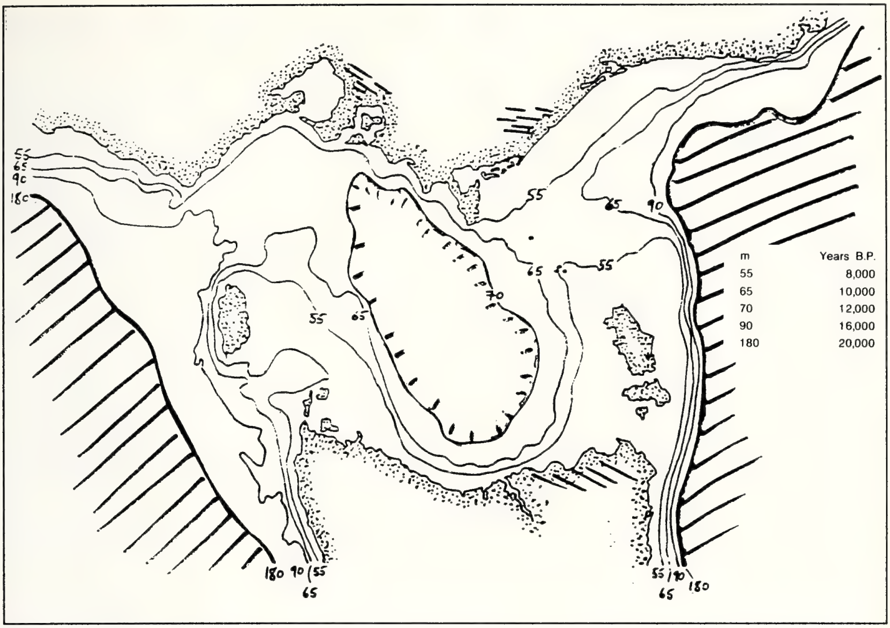

Fig. 5. 20 000 years ago, a sea level 180 m lower meant that Victoria and Tasmania were joined; and so the present central Victorian coast was a considerable distance inland. (From Bowler 1995?).

against the west side. Prevailing westerly winds moved the lime-rich sand inland and formed a number of parabolic dunes, some of which reached thicknesses of 100 m. Calcarenite remnants of these dunes occur elsewhere along the west coast and on the Glennie and Anser Island Groups. The calcarenites were until recently quarried for local use as fertilizer lime.

In the Darby River area peats have accumulated in fresh water swamps between calcarenite dunes. Some peat layers are up to 1 m thick. A radio-carbon date of 5 880 years was obtained for the bottom of one layer.

Recent sand deposition has built the present beaches and coastal dunes since sea levels rose to about their present height 7 000 years ago. Buried shell beds and Aboriginal midden deposits are common in sand dunes all around the Promontory. The oldest of these are dated at 6 550 years and can be seen along the west coast between Yanakie and Darby River (Coutts 1970).

Alluvial and swamp deposits consisting mainly of detritus derived from the weathering of the granite extends to the coast from the foot of the granite mountains and hills. Large low-lying areas of poorly drained country occur, for example, to the north of the Vereker Range where the land drains to Corner Inlet (Pl. 2A). Coastal dunes bank-up swamp deposits behind most beaches and cause rivers to flow parallel to the coast for some distance before entering the sea. The swamp and river behind Sealer's Cove is a fine example of this. An extensive swamp has formed behind the Five Mile Beach. Similar features occur at Three Mile Beach, Darby Beach, Norman Bay, Oberon Bay and Waterloo Bay.

Bass Strait was created in its present form when the land link with Tasmania was severed as a result of sea level rises due to the decline of the last worldwide glaciation. The coastline of Wilson Promontory shows the results of coastal submergence with many off-shore islands, active erosion of granite and calcarenite cliffs, and sand accumulation in the more sheltered bays (Jenkin 1968).

I trust that this brief journey through 400 million years of the 'Prom's' history will set the scene for any Naturalist to enjoy the beauty and diversity of Wilsons Promontory, so that they can appreciate it now and protect it for the future.

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Minerals on Wilsons Promontory

William D. Birch[1]

Abstract

Wilsons Promontory first lured geologists and prospectors in the late 19th Century, but with disappointing results. The relatively barren granite making up most of the promontory imparted scenic qualities but provided little in the way of economic minerals. Considerable effort went into establishing tin mining operations in low-grade alluvial gravels overlying the granite at Mount Hunter between about 1918 and 1925, when the metal was of strategic importance. Its National Park status now places Wilsons Promontory out-of-bounds to mineral collectors, but it may still be of interest to geologists studying granite and heavy mineral assemblages. (*The Victorian Naturalist* **115** (6), 1998, 306-309).

Introduction

The remoteness and rugged terrain of Wilsons Promontory failed to deter prospectors who were scouring the Colony of Victoria looking for gold late last century. The promontory, however, appeared to offer little of commercial interest. In the meantime, the perennial opponents of the miners, the preservationists, were intent on securing the promontory as a National Park. Their efforts were to eventually succeed, in 1898, apparently putting an end, so they thought, to all thoughts of mining in the region.

Early geologists visiting the region had observed that the promontory consisted of granite. In fact, a small granite quarry was opened at Refuge Cove in 1859-60 to supply stone for new roads in Gippsland. In 1869, Robert Smyth made reference to the presence of 'schorly' granites, and to very large crystals of black tourmaline procured from veins by one Lieutenant Morrison. In another early description, in 1876, Reginald Murray noted the presence of coarse and fine-grained granite, containing veins and masses of tourmaline and quartz. Some tourmaline specimens were collected and exhibited in the Victorian Hall in the *Colonial and Indian Exhibition* held in London in 1886. In 1900, display cases in the museum of the Geological Survey of Victoria contained samples of sands from the promontory bearing garnet, zircon and tourmaline.

Murray (1876) also noted that unsuccessful prospecting operations, presumably for

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gold, had been carried out on two thin quartz veins near Mount Singapore. He was no doubt referring to the Mount Singapore Quartz Prospecting Company's two shafts, sunk on a lease on the south slopes of Mount Singapore in 1866 (Lennon 1974) (Fig. 1).

The discovery, in about 1904, of alluvial tin ore near Mount Hunter (348 m) by Ernest Lawson, sparked more intense geological interest in the promontory. The ore was in gullies on the northern slopes of the mountain, about 2 km inland from the coast north of Chinaman Bay (now Chinaman Long Beach). The Mining Department regarded tin as a strategic resource, and many Victorian deposits had been exploited, including the small Toora tin-field, about 30 km northwest of the promontory (Cochrane 1971). In 1906, the Director of the Geological Survey, Edward Dunn, examined a parcel of cassiterite (tin oxide) grains obtained at Mount Hunter and reported favourably on its richness in the light of increasing world tin prices (Dunn 1907). After the First World War, between 1914 and 1918, tin became even more valuable. Several syndicates were formed to lobby the Government for permission to mine in the National Park, with the Frances Richardson party being successful. While they were exploring at the site in 1918, they were visited by another Government Geologist, J.P.L. Kenny, who made some suggestions as to how the deposit could be mined and took samples for assay. Kenny's samples came from deposits being explored by shafts and tunnels at the head of Lawson's Creek, running eastwards from the saddle north of Mount Hunter (Fig. 2).

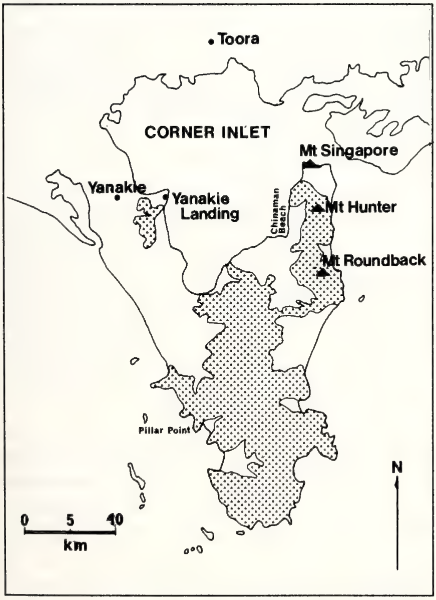

Fig. 1. Simplified map of Wilsons Promontory. Main granite areas shown by symbols.

The Government gave its final approval to grant mining leases late in 1919, but nearly four years elapsed before the Mount Hunter Tin Mine company issued a prospectus. Most of 1924 was spent getting equipment to the site, setting up the plant and constructing the necessary accommodation. The work involved the installation of a pipeline from the coast bringing water to sluice deposits at the junction of two west-trending gullies, about 600 m west of the Lawson's Creek workings (Fig. 3). Payable ore was first obtained in December 1925, but the operations were plagued by breakdowns and mismanagement, with several calls for extra funds being made to shareholders. Despite some rich patches, the tin ore was widely dispersed and difficult to mine. Government Geologist, W.H. Ferguson, was asked to inspect the operations, but after his unfavourable report (Ferguson 1936), the mine closed early in June 1925. Only 3 cwt (about 150 kg) of cassiterite was produced from the deposit. A more detailed account of the discovery and exploitation of the Mount Hunter tin mine has been written by McKellar (1993).


Fig. 2. View of the northeastern peninsula of the promontory from Yanakie Landing. Mount Hunter is the highest point.

Fig. 3. Tin mining operations at Mount Hunter 1924-25. Photo courtesy Historic Places Section, NRE.

Geological Overview

The granitic rocks of the promontory form part of a large zoned batholith, the Wilsons Promontory Granite, which has been dated at 384 million years (late Devonian) (Richards and Singleton 1981), A weathered contact between the granite and Palaeozoic metasediments is exposed near Yanakie Landing. Wallis (1981, 1988) divided the granite into seven components or members on the basis of variations in texture, mineral content and chemical composition. The granite mass comprising the northeast peninsula of the promontory, from Mount Roundback in the south to Mount Hunter and Mount Singapore in the north, was named the Singapore Granite. It consists mainly of fine to medium-grained, pale grey granites with prominent feldspar crystals.

The granites have undergone deep weathering, mainly during the Mesozoic (Hill and Joyce 1995). Erosion has resulted in widespread tor formation, as well as extensive Tertiary to Recent deposits composed of granitic regolith material. These include the Yanakie Isthmus north of the promontory, deposits in swamps and alluvial flats, slope deposits due to slumping, and the quartz sands of the present-day beaches.

The Mount Hunter tin deposits are in alluvial gravels of uncertain age but possibly early Tertiary (Eocene) if they are correlated with alluvial tin-bearing gravels at Toora (Spencer-Jones 1955). Kenny (1921) reported that the tin-bearing wash in Lawson's Creek was about 6 m wide and 30 to 40 cm thick, beneath a 6 m thick overburden of granitic sand and clay. In the sluiced area, the overburden was mainly windblown sand between about 1 and 10 m thick, with the tin-bearing wash averaging only 15 cm. The deposit is considered to be within a former lead, or old stream valley. The source of the cassiterite is undoubtedly granitic. The elevation of the deposit, and the fact that the promontory has been at a relatively high level since the Mesozoic (Hill and Joyce 1995), suggest the source rocks were nearby in the Singapore granite.

Some Minerals found on the promontory

Garnet

The iron-rich garnet, almandine, is a minor constituent of the granites on Wilsons Promontory. Usually it forms tiny scattered crystals. However it occurs as large dark red crystals concentrated in a patch of biotite-rich granite on Pillar Point, south of Squeaky Beach. Fragments of almandine are widespread in beach sands around the coast and may become concentrated in places. Near Yanakie Landing, on the western shore of Corner Inlet, Murray (1876) described fragments of garnets occurring in deposits derived from weathered granite. A sample in the Museum of Victoria collection, possibly that described by Murray, contains grains of dark red, orange and bright pink garnet. Analysis shows these are all almandine, suggesting they were locally derived, but possibly from different zones in the Wilsons Promontory Granite. These deposits at Yanakie Landing overlie weathered granite and are possibly the equivalent of the Haunted Hills Formation (Pliocene) in South Gippsland.

Cassiterite

The tin ore at Mount Hunter consisted of grains of cassiterite up to several centimetres across. Although they are well-rounded, many grains show traces of the original crystal faces. Most of the cassiterite is a dull brownish grey to black, although varieties such as ruby and resin tin have been noted (Fig. 4).

Corundum (Sapphire)

In the gravels from Yanakie Landing described by Murray (1876), green and blue sapphires were identified by noted mineralogist George Ulrich, who examined the samples. These sapphires would not have come from the granites on the promontory, but would have formed in basaltic volcanic rocks, similar, for example, to the Older

Fig. 4. Quartz crystal containing tourmaline, and grains of coarse cassiterite, from the Mount Hunter Tin Mine. Quartz crystal is 8.5 cm high. Museum of Victoria specimens.

Fig. 5. Aggregates of schorl crystals from Wilsons Promontory (larger is 11 cm long). Museum of Victoria specimens.

Volcanic lavas of South Gippsland. An unknown basaltic source to the north seems likely for the sapphires. The Museum of Victoria sample referred to above contains a few small pinkish to purple sapphires. Murray also makes reference to 'almandine ruby', which is probably not the pink gem variety of corundum known as ruby, but rather bright pink garnet.

Tourmaline (Schorl)

The common black species of tourmaline, schorl, is widespread in the granites on the promontory. It occurs as aggregates of black crystals, rarely up to 30 cm or more across, in pegmatites, quartz veins and small cavities in the granite. Schorl also occurs as thin veins, as nodules and as small crystals scattered through fine-grained phases of the granite. Well-terminated crystals appear to be uncommon. At the Mount Hunter Tin Mine, schorl was commonly found with cassiterite, as water-worn crystals up to 7 cm long and 2.5 cm thick, as masses up to 30 cm across intergrown with quartz, and as boulders of fine-grained quartz-tourmaline. Ferguson (1936) noted that some dark green tourmaline was also present (Fig. 5).

Conclusion

It could never be claimed that Wilsons Promontory is a mineral collector's paradise. Nevertheless it has an interesting, albeit short, mining history. Its status as a National Park probably means that its potential to yield more mineral discoveries of interest to collectors will be limited. However, there is possibly some scope for research on heavy mineral grains such as garnet and zircon in the Tertiary gravel deposits, which may assist in determining their provenance.

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The Vegetation of Wilsons Promontory National Park

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Abstract
The vegetation of Wilsons Promontory is briefly described according to the soils and landform. Some related management problems are discussed. These include the changes in lowland heath and grassy woodland which were initiated by an early period of introduced grazing and later compounded by fire exclusion. (*The Victorian Naturalist* **115** (6), 1998, 310-321).

Introduction

The landform of Wilsons Promontory is dominated by a Devonian granite massif, separated from the mainland and linking all land 100 m above sea-level. The granite falls steeply to the ocean along the eastern and southern coastlines. Exceptions occur where dune ridges have created swamps in ancient, coastal bays. To the north, a broad and shallow-sloping coastal plain of siliceous sand separates the granite from Corner Basin. This plain flanks the granite on the western side. Here the siliceous sands have been overlain by hummocks of carbonaceous sand. The granite includes the major mountains which ascend southward in irregular steps along a rocky promontory from Mount Singapore (147 m) to Mount LaTrobe (754 m). The mountains are steep-sided and the gullies deep. The vegetation is predominantly forest, heathy woodland or hilly treeless heaths, depending on moisture and drainage. Flat sheltered areas support rainforest with wet forest on higher southern aspects. The soils are acidic consisting of either gradational or podzolised profiles.

During the Tertiary period, siliceous sands from the east coast joined the original island of granite to the mainland, and formed Corner Basin. The sands filled broad bays left by the irregular, granitic coastline. Sandy beaches developed behind projecting spurs of rock. The vegetation is typically heath. Podzolised acid soils have bleached upper horizons above yellow brown sands that may include coffee rock.

Sedimentation during the Quaternary included aeolian, calcareous sands, obtained from exposed seabeds off the west coast during periods of low sea level. Wind action built extensive dunes to 80 m above sea-level overlying the Tertiary sands on the Yanakie isthmus. Dunes of 'pale yellow' calcareous sand predominate on the isthmus and support a scrubby woodland or grassland. Neutral to high soil pH characterizes most of these immature soils. Older Pleistocene dunes containing aeolianite, and dunes of 'red', to slightly acidic sand are more restricted. Deposition of alluvium and peat has continued to fill the lower areas, particularly where foreshore dunes have deflected the entry of streams to the sea. Where drainage is impeded, wet heaths and swamps have formed on sandy peats.

The distinction between soils derived from granitic/siliceous or calcareous parent material influences the vegetation. The former soils cover a wide range in elevation, topography and precipitation. Although of low fertility, nutrients are readily available to plants. The vegetation is dominated by heath, heathy forest or woodland. In contrast, vegetation forming on the calcareous sands have less variable soils, topography and precipitation. Nutrients are much less available due to high soil pH. The vegetation is generally a mixture of grassy scrub or woodland.

The park has a temperate climate with an annual rainfall of 1050 mm recorded at the SE Point (Parsons 1966). This is estimated to rise to at least 1500 mm along the Vereker Range. Half the rainfall is shared equally between spring and autumn. Winter rainfall is approximately twice that of summer. Temperatures are mild due to the moderating influence of the sea, and frosts are few. Proximity to the sea induces orographic clouds along the higher ranges which are frequently mist covered when the remainder of the park is clear. Winds prevail from the W and to a lesser extent the SW all year. In winter, NW winds are more

[1] 'Felton,' 5 Old Coach Road, Mount Dandenong, Victoria 3767.

frequent than SW. In spring and autumn, NE and NW winds are both prevalent.

Aborigines are known to have occupied the area from at least 6500 years BP. Kitchen middens and other archaeological sites occur near the coast, north of Darby River, and on Singapore Peninsula.

Vegetation

Granitic soils

Montane and hilly

Soils on granite vary from a few centimetres covering bedrock, to at least 200 cm. Uniform skeletal soils occur near granite outcrops (Parsons 1966). Outcrops are conspicuous in treeless, hilly areas and generally support dry heath dominated by White Kunzea *Kunzea ambigua* and to a lesser extent Bush Pea *Pultenaea mollis*. Woodlands of Drooping She-oak *Allo- casuarina verticillata* with a sparse shrubby understorey and litter, occur on steep spurs immediately overlooking the sea, and infrequently further inland, for example Vereker Outlook. Podzolised, gravelly, duplex soils occur beneath heath, heathy woodland and a range of damp heath associations. Common dominants include a mixture of Swamp She-oak *Allocasuarina paludosa*, Scented Paperbark *Melaleuca squarrosa*, Prickly Teatree *Leptospermum continentale*, Bluntleaf Heath *Epacris obtusifolia*, Austral Grass-tree *Xanthorrhoea australis*, Pink Swamp-heath *Sprengelia incarnata* and Wattle Mat-rush *Lomandra filiformis*.

Gradational soils commonly support forest and woodland which form a continuum along a moisture gradient. The drier end is indicated by a Messmate Stringybark *Eucalyptus obliqua* woodland, often mixed with Shining Peppermint *E. willisii*. Many understorey species are typical of dry heath. In addition, taller shrubs of Prickly Moses *Acacia verticillata*, Bush Needlewood *Hakea decurrens*, Hairpin Banksia *Banksia spinulosa* dominate a scrambling stratum of Guinea Flower *Hibbertia aspera*, Wire Grass *Tetrarrhena juncea* and Austral Bracken *Pteridium esculentum*. Under moister soils, woodland is replaced by damp forest indicated by Hazel Pomaderris *Pomaderris aspera* and Prickly Currant-bush *Coprosma quadrifida* with Tall Sword-sedge *Lepidosperma elatius* often providing continuous ground cover. The overstorey may contain *E.obliqua*, Brown Stringybark *E.baxteri* or Yellow Stringy-bark *E.muelleriana*. Gullies support Soft Tree-fern *Dicksonia antarctica*, Hard Tree-fern *Cyathea australis*, King Fern *Todea barbara*, Redfruit Saw-sedge *Gahnia sieberana*, False Bracken *Calochlaena dubia*, Tall Sedge *Carex appressa* and Fishbone Water-fern *Blechnum nudum*. Wet sclerophyll forest occurs on deeper soils with protected aspects. Mountain Ash *Eucalyptus regnans*, *E.obliqua* and their hybrids, dominate Blackwood *A.melanoxylon*, *P.aspera*, Blanket Leaf *Bedfordia arborescens*, Musk Daisy Bush *Olearia argophylla* and *Coprosma quadrifida* with Mother Spleenwort *Asplenium bulbiferum*, Finger Fern *Grammitis billardieri*, Delicate Hook-sedge *Uncinia tenella* in gullies. Widespread introgression between *E.obliqua* and *E.regnans* over a long period has produced a fire sensitive hybrid with deciduous bark on the trunk and branches (Ashton and Chappill 1989). This occupies sites typically suited to more fire resistant eucalypts and although significant areas of wet forest and lowland rainforest remain intact, approximately 14% of the tall forest within the reserve has been destroyed by fires in the last 90 years. Large areas of potential damp and wet sclerophyll forest are now unstocked with eucalypts and are dominated by scrub.

Flat sheltered valleys

Rainforest occurs on gently sloping, sheltered sites at the base of the Vereker Range while rainforest species remain stunted and exposed by past fires along its crest. Soils have formed from deep deposits of granitic hill wash. In higher areas only scattered remnants remain of the deep peaty soils that accumulated before the change to european fire regimes. The main areas occur west of Five Mile Swamp and in Lilly-Pilly Gully (Pl. 2C) while a small and disturbed area occurs in a tributary to Darby River. Warm temperate rainforest dominated by Lilly-pilly *Acmena smithii*, *A. melanoxylon* and unusual mixtures with the higher elevation cool temperate species, Myrtle Beech *Nothofagus cunninghamii* and Sassafrass *Atherosperma moschatum* occur. Widely scattered eucalypts, particularly Blue Gum

E.globulus ssp. *globulus*, emerge from a rainforest canopy forming at 15-20 m. A scattered stratum of *A. melanoxylon* projects between the eucalypt and rainforest crowns. In these areas few shrubs occur beneath the tree canopy and the ground stratum is covered by ferns, particularly Mother Shield-fern *Polystichum proliferum,* Hard Water Fern *Blechnum wattsii* and *B.nudum.*

Siliceous soils

Flat sand sheets and undulating dunes

Wave action has formed parallel beach ridges. The dunes contrast with the low energy shoreline and extensive mud flats inside Corner Basin. Extended leaching of the coarse, quartzose sands from the east coast have produced an infertile, neutral to acidic, substrate. Extended leaching has lowered nutrient status, pH and caused podzolisation. Dense heath characterizes this soil type. Adaptations of plants to the low nutrients include internal recycling of nutrients and interaction with soil micro-organisms, mycorrhizas, proteoid roots, nitrogen fixing rhizobia and actinomycete-like organisms (Malajczuk and Glenn 1981).

Heath at Wilsons Promontory forms a continuum from dry to wet. Dry heath dominants include Silky Tea Tree *Leptospermum myrsinoides, L.continentale* and She-oaks *Allocasuarina paradoxa* and *A.media.* In low lying, poorly drained situations, a hard pan of coffee rock may form in the sub-soil. These soils support damp heath. Dominants may include *M.squarrosa, A.paludosa, X.australis, E.obtusifolia, S.incarnata, L.continentale* and Spreading Rope-rush *Empodisma minus.* Vegetation richer in Button-grass *Gymnoschoenus sphaerocephalus,* Common Rapier-sedge *Lepidosperma filiform* and Tassel Cord-sedge *Restio tetraphyllus* may indicate locally wet conditions. Damp heaths often form an ecotone with the dry heath of deep, well drained sand sheets, and the wet heaths of peaty soils in swampy depressions. Damp heath also forms on colluvial sands where moisture is trapped above the underlying granite. Colluvium has accumulated in sloping sheets from higher areas of granite (Tuddenham 1970).

Low and older dunes occur south of Silver Swamp to the Vereker Fire Trail and north of the Five Mile Road to Singapore Peninsula where uniformly fine, wind blown sand has accumulated against the higher rocky areas. They have an east-west alignment in response to the prevailing winds, often occurring as small islands in the heath. The improved drainage supports a Saw Banksia *Banksia serrata, E.obliqua* woodland with a heath understorey often including Showy Bossiaea *Bossiaea cinerea.*

Low-lying areas

Anaerobic conditions inhibiting the decomposition of organic matter occur over large areas where the water table is at, or close to, the surface. Corridors of peat follow the principal drainage lines. At Tidal River, peat has formed to a depth of 2 m, over a period of approximately 6000 years (Parsons 1966). Saline, sandy peats occur along flats subject to tidal influence and support rushlands of Sea Rush *Juncus kraussii,* Knobby Club-rush *Isolepis nodosa,* Selliera *Selliera radicans* and succulent herbfields of Beaded Glasswort *Sarcocornia quinqueflora, Selliera radicans,* Creeping Brookweed *Samolus repens* or Glaucose Goosefoot *Chenopodium glaucum,* Sea Cellery *Apium prostratum* and Karkalla *Carpobrotus rossii.* Narrow shore platforms around Corner Inlet separate the tidal zone from Swamp Paper-bark *Melaleuca ericifolia* wet closed scrubs. These are restricted by increasing salinity and decreased aeration, but may occasionally be subject to tidal inundation (Parsons 1966). The dominant is invariably *M.ericifolia* but mixtures with *M.squarrosa* occur. Generally one or occasionally several tall graminoids form the understorey; e.g. *Gahnia sieberana,* Brickmakers Sedge *G. grandis,* Tall Sedge *G. clarkei, Lepidosperma elatius* and Variable Sword-sedge *L. laterale.* Extensive rushlands occur immediately south of Shallow Inlet and at Cotters Lake. These swamps are associated with physiography formed during periods of higher sea level. They appear to have dried out and consolidated over recent decades. Their composition includes a marshy society indicated by Running Marsh-flower *Villarsia reniformis,* Streaked Arrowgrass *Triglochin striatum* and a drier herbacous phase distinguished by Coarse Twine-rush *Leptocarpus brownii,* Australian Salt Grass *Distichlis distichophylla,* Salt Couch

Sporobolus virginicus, Mat Grass *Hemarthria uncinata*, Angled Lobelia *Lobelia alata* and Pennywort *Hydrocotyle sibthorpioides*.

Peaty sands are widely distributed and consist of the amorphous remains of Melaleucas incorporated into the sand (Parsons 1966). Wet closed heath of *M.squarrosa, L.continentale*, Square Twig-rush *Baumea tetragona* and Pouched Coral Fern *Gleichenia dicarpa* cover extensive areas in association with the drainage lines and grade into damp heath. In seasonally or perpetually flooded areas, diversity is greatly reduced. A closed heath and scrub of *M.squarrosa, M.ericifolia* and *L.continentale* dominating a wetland understorey of Pithy Sword-sedge *Lepidosperma longitudinale*, Bare Twig-rush *B.juncea*, Soft Twig-rush *B.rubinginosa* and *Villarsia reniformis* has formed along drainage tracts. Flooded swales between the dunes or small, marginally lower swamps within the damp heath, support a tall sedgeland dominated by *B.rubiginosa* and *L.longitudinale* in association with Zig-zag Bog-rush *Schoenus brevifolius*, Common Scale-rush *Lepyrodia muelleri*, Broad-leaf Cumbungi *Typha orientalis* and Small Tongue-orchid *Cryptostylis leptochila* and species common to the flooded closed heath. Many of these flooded rushlands are fringed by a narrow band of Melaleucas. Seasonally flooded deeper swamps have significant areas of non vegetated silt. Bog Gum *Eucalyptus kitsoniana* occurs occasionally along the margins. Fibrous peat may accumulate beneath sedge dominated communities more resistant to anaerobic decay (Parsons 1966), for example vegetation with a high cover of *Gymnoschoenus sphaerocephalus*.

Telegraph and Silver Swamps are fronted by a low open scrub or a tall grassland of Woolly Tea-tree *Leptospermum lanigerum*, Leafy Twig-rush *Cladium procerum* and *T.orientalis* where the fresh water table interfaces with the coast. *Baumea juncea*, Bog-rush *Schoenus carsei* and the lower-growing species of *Gahnia*, Coast Saw-sedge *G.trifida* and Chaffy Saw-sedge *G.filum* may be present. *Leptospermum lanigerum* which occurs as a sparse low shrub above a graminoid dominated understorey, also forms a tall shrub stratum above a diverse mesophylous understorey, including several species of *Hydrocotyle*, *Triglochin*, Water Parsnip **Berula erecta*, Golden Dodder *Cuscuta tasmanica*, Scrub Nettle *Urtica incisa* and Sea Cellery *Apium prostratum*. The community occupies swales and flats at the northern tip of Singapore Peninsula, significant areas of Telegraph Swamp, and small inter-dune depressions along the west coast.

Mangroves, *Avicennia marina* subsp. *australasica* occur sporadically at the extremity of their range in Corner Basin, and in the mouth of major tributaries. Those at Corner Basin may be relics of warmer seas during the Tertiary or early Pleistocene. The mangroves at Corner Basin are diminutive. Poor silt accumulation may contribute to their reduced stature (Macnae 1966).

Calcareous soils

Sand binding grasses, for example Hairy Spinifex *Spinifex sericeus* or Marram Grass **Ammophila arenaria* occupy the foreshore berms. Sea Spurge **Euphorbia paralias* is a conspicous, recent, successful coloniser of this zone. Succulent mat plants, for example *Carpobrotus rossii*, Dune Fan-flower *Scaevola calendulacea* commonly occur between the foredune and the first stabilized dune. Coast salt bush *Atriplex cinerea* is common along the east coast foreshore. Pioneering shrubs of the foredune and dune scrubs, consolidating undifferentiated sand may include White Correa *Correa alba*, Coast Tea-tree *Leptospermum laevigatum*, Common Boobialla *Myoporum insulare*, Sallow Wattle *Acacia longifolia*, Coast Daisy-bush *Olearia axillaris*, Coast Everlasting *Ozothamnus turbinatus*, Coast Beard-heath *Leucopogon parviflorus* and Seaberry Saltbush *Rhagodia candolleana*.

Massive, unstable dunes containing aeolianite, dominate the northern end of the isthmus. More generally the topography is distinguished by a series of vegetated and irregularly distributed, parallel dunes, oriented perpendicular to the coast. The soils are markedly alkaline, stabilized by vegetation and have steep sides. They produce interdune corridors of variable width and up to 45 m below the dune crests.

* introduced

Excavated water holes indicate a water table that is frequently within several metres of the surface in low lying areas. As a result of the extensive vegetation change from grassland and open woodland to a closed scrub following the removal of grazing; rainfall interception, evaporation, and transpiration are all likely to have changed, and may have influenced recharging of the aquifer.

Soil age and leaching typically increase with distance from the coast, causing pH, and fertility to decrease, eventually forming an iron podzol (Pidgeon 1940; Turner *et al.* 1962; Robin and Parsons 1976). Where the podzol includes a hard pan, the dune woodland is commonly replaced by a eucalypt woodland or forest that may include banksias. The understorey has a distinct heath component and often contains bracken and hard sedges. Mixed eucalypt-banksia woodlands with heath understorey are common on siliceous sands. They are more restricted on the isthmus but remnant vegetation suggests they may have occurred on the airstrip before it was cleared. Historic records indicate the area to have been thickly timbered with fair size eucalypts and a few scattered blackwoods (Kershaw *et al.* 1913; Kershaw 1915). The area was either ring-barked or succumbed to over-browsing by koalas (*Foster Mirror* 27 July 1939) before 1938 when it was cleared for an aerodrome (Lennon 1988).

Restricted areas of older dunes occur south from Cotters Lake. Typical soils are red or dark brown, non structured sands with finely broken sea shells and quartz grains, overlying aeolanite or dune limestone. Where these soils form without dune limestone, weakly podzolised, iron leptopodzols may occur. The vegetation consists of Coast Banksia *Banksia integrifolia* woodlands with understoreys of scattered shrubs and a ground cover of bracken and herbs which includes White Elderberry *Sambucus gaudichaudiana,* Kangaroo Apple *Solanum aviculare* and Bower Spinach *Tetragonia implexicoma* along drainage lines.

More generally the calcium carbonate content is sufficiently high for redeposition to form aeolanite, preventing podzolisation and succession toward woodland with heathy understoreys. Representative soils are unstructured, grey brown sands, overlying deep, yellow brown sands containing 60-70% calcium carbonate. A scrubby woodland of *B.integrifolia, L.laevigatum, L.parviflorus* and *A.longifolia* may form on these immature soils (Turner *et al.* 1962), particularly following disturbance (Hope 1974). This community mixed with *A .verticillata* once dominated the isthmus. Interdune scrubs of *L.lanigerum* with a herbaceous understorey were associated with the water table in depressions. In 1969, *L.laevigatum* was confined to ridges and dunes as isolated shrubs and thickets. In the grass-sedge hollows and small sand plains, it was infrequent and reduced in size, usually between 10–50 cm (Burrell 1969). In 1971 the area was described as irregular dunes carrying fine old trees of *A.verticillata* and *B.integrifolia* with shrubs of *L.parviflorus,* Coast Pomaderris *Pomaderris oraria,* Sweet Bursaria *Bursaria spinosa, A.longifolia* and *L.laevigatum* (Turner and Ashton 1971). Flats and swales between the dunes supported a grassland, rushland or open woodland with *B.integrifolia* more abundant south of Telegraph Swamp. Blady Grass *Imperata cylindrica* was a common component of the rough grassland (Turner and Ashton 1971; Hope 1974). By 1973 an expansion in the cover and abundance of *L.laevigatum* was evident (Leech 1973).

Vegetation management

Early park management attempted to protect the fauna, reduce the fire frequency and introduce new species with the intent of conserving all Victorian plants and animals (Hardy 1906). By 1941, 30 species of fauna and 60 species of native plants totalling 268 specimens had been introduced (Kershaw 1941). The policy of acclimatization was questioned when trout were released into Darby River *(Argus* 14 July 1939) and the emphasis toward conserving natural ecosystems was recognized officially by the Committee of Management in 1963. Before dedication as a park, cattle grazing was widespread on the isthmus as far south as Darby River. Mobs were also driven to the rich herbfields at the end of Singapore Peninsula and to the grassland and woodland that once existed behind Oberon Bay, before the widespread invasion by Coast Tea-tree.

Grazing on the isthmus continued until 1969 when this area was added to the park and winter agistment continued until 1992. The comparatively successful exclusion of fire after 1951 and the reduction in browsing pressure accompanying the phase-out of cattle has initiated a number of widespread changes to the lowland vegetation.

Heathland burning regimes

Fires in heathland are recommended every 12–15 years to maintain a vigorous, diverse ecosystem (Gill and Groves 1981). Population changes in many animal species specialized to heath habitats indicate that a 12–15 year absence of fire is the upper extreme. There is a greater latitude for longer, rather than shorter, periods to occur without floristic change and it is probable that the potential of the heath flora to respond to fire will change little for periods well in excess of 20–25 years but after 40–50 years, floristic and faunal diversity in heathland is greatly diminished. Senescence may be evident with pathogen and insect damage or an invasion of *Kunzea ambigua* and *Leptospermum laevigatum*. At the other extreme, frequent fires, less than 5-7 years apart may cause a change toward sub-shrubs and graminoids (Gill and Groves 1981). This may favour some heath specializing animals, but at the cost of floristic diversity, and species utilizing later stages.

Aboriginal fire regimes were evidently suitable to maintain a complex shrubby heath. The recent fire history suggests that, free of deliberate burning, a combination of frequent and longer fire intervals sometimes occurs where there may be periods of a decade or more in which lightning initiates frequent fires, followed by long periods without fire. Fauna living in heath vegetation would appear to be best suited by an intricate mosaic of different age classes, allowing populations to build up and disperse as the heath matures. Fires of this type may occur naturally where the vegetation causes a discontinuity in the fuel types but they are less likely in the expansive heathland of the northern management area under hot conditions. Under most circumstances it would be desirable to maintain several age classes in different areas, if this can be done without soil disturbance. This would minimize adverse impacts on the flora of an unplanned fire following shortly after a management burn.

Burning is normally conducted in autumn to allow a hot fire under controllable conditions, and cause minimal disruption to the breeding cycles of dependent fauna. Where the plants are obligate seed regenerators, fire temperature may be critical to their survival. Low intensity spring burns may fail to break dormancy in soil seed and favour vegetative regrowth during summer. After fire, seed harvest by ants increases. Fires sufficiently intense to stimulate heavy seed release may be necessary for some species to satiate predators and enable seed to accumulate in the soil. This is particularly important for species that flower only after burning and whose seeds may be vulnerable to ants, for example *Xanthorrhoea* sp. (Andersen 1988). For serotinous species, hot fires in summer or early autumn stimulate rapid dehiscence so that seedlings can establish with minimal competition (Lamont and Barker 1988). Russell and Parsons (1978) found seedling establishment rare at Wilsons Promontory, but where these species are dominants, for example *Hakea decurrens*, fire intensity can significantly modify the vegetation structure.

Succession in coastal heathland

Coast Tea-tree, *L. laevigatum* was first observed invading coastal heath in the 1950s (Burrell 1969), while the invasion of *K.ambigua* become apparent in the early 1970s. Both species have the potential to replace the heath and significantly alter habitat over vast areas.

Prior to the recent expansion, *L.laevigatum* was confined to disturbed coastal dunes at Wilsons Promontory (Parsons 1966). In contrast, heath is the end point of a succession that involves significant soil changes including the loss of nutrients. The invasion is therefore unexpected and not easily explained (Burrell 1969, 1981). Less frequent burning appears to be implicated in the change. Establishment and growth of Coast Tea-tree has been observed in the heath without burning (Frood 1979; Molnar *et al.* 1989; Judd 1990). Soils of the mature senescent heathlands at Wilsons Promontory are more nitrogen-rich than those of soils subject to frequent burning (Keleher 1992). It is possible that the leaching and volatilization of nitrogen compounds, associated with regular burning, may off-set the nutrient

accumulation through biological and atmospheric processes, forming a barrier to invasion by lowering fertility.

Plants of both *Leptospermum* and *Kunzea* are killed by fire. Unlike *Kunzea* which builds a soil seed bank, there is no soil storage of Coast tea-tree seed (Burrell 1969; van Gameren 1977; Judd 1990). Because its seed is shed over the summer, burning in spring is an effective means of reducing Coast Tea-tree in some instances, even in heaths that may have a 70-year history of tea-tree dominance (Fletcher 1987; Molnar *et al.* 1989). Alternatively, where capsules retain seed, two fires within a five year period may reduce its cover quickly (Judd 1990). Such a fire frequency can threaten species depending upon seed for regeneration, and it may be best to manage for a phased decline, involving repeated burning over a long period.

Phytopthora cinnamomi

Dry sclerophyll forest, woodland, heath and swamp communities on acid soils are all vulnerable to a virulent root pathogen, *Phytophthora cinnamomi,* introduced to the park during suppression of a fire in 1962 (Weste and Law 1973), then spread in road making gravels (Weste 1975). The fungus affects a wide variety of heathland plants. Many resistant species are graminoids (grasses, sedges and lilies) and as a consequence, after the initial obvious decline in vigour and health, there may be floristic and structural changes in the vegetation. Over a five year period, a sclerophyll shrub woodland near the Vereker Spur changed to an open sedge woodland, characterized by reduced tree density, loss of susceptible species and an increase in the cover of resistant sedges (Weste 1981).

Virulence declines in older soils due to fewer host roots, microbial competition and soil fungistatis. Periods of low temperature and drought may further reduce the activity of the fungus which can persist as resistant chlamydospores for a long period, particularly amongst gravel. A disease outbreak may depend upon a resumption of favourable temperature and moisture, transport to a new site, or the recovery of sufficient host species on the previously infected site. Currently the fungus is believed to be restricted to relatively few areas and its virulence is low.

Succession in coastal woodlands

The earliest interpretation of the isthmus vegetation is derived from pollen buried in peat (Hope 1974). This indicated a long period from 4000 y BP when the area was dominated by an *Allocasuarina* woodland. Much later the representation of *Allocasuarina* pollen declined and still later *Banksia* increased, accompanied by a marked expansion of grasses. The archaeological record, deduced from an examination of middens (Coutts 1970), may give some indication of the processes leading to the earlier change in composition. Aboriginals occupying the isthmus from 6500–3000 years ago, the earliest known date of occupation, camped amongst well vegetated and stable dunes. These appear to have been well grassed *Allocasuarina* woodlands. Whilst in the area, their diet consisted exclusively of fish, as no animal bones were found in their camp hearths. In contrast, later tribes camped amongst unstable dunes and mixed fishing with hunting. It can be argued that their use of fire to attract game led to dune instability through its impact upon the vegetation. (Tuddenham 1970). A change in the calcareous dune environment may have occurred approximately 3000 years ago, induced by a change in Aboriginal culture. This change may have been correlated with an increase in the representation of *Banksia* and *Poaceae* as these species spread, since Hope (1974) suggested that burning associated with cattle grazing was responsible for the last expansion.

The earliest post-European vegetation descriptions are annotated on maps. Smythe's 1848 map indicates extensive mobile dunes (Tuddenham 1970) and a survey map in 1871 records the area as 'cups and hummocks covered with Native grasses, dryland Ti-tree and patches of stunted Gum and She-oak'. The early grazing blocks were south of Cotters Lake, principally on the older, less alkaline soils (Ewart 1909, Lennon 1988) but a long period of grazing and burning may have been responsible for the present discontinuous cover of *B.integrifolia* in this area. Persistent heavy grazing by cattle, rabbits, wombats and kangaroos, combined with altered burning regimes, has caused a change in the vegetation of this land system.

Early aerial photographs of the isthmus (1941) show low tree and shrub cover widely scattered on dunes. Many large-crowned and apparently open grown trees were distributed in the grassland with a low, but variable density. A few surviving individuals and many stumps prove that the trees were mostly *B.integrifolia*, although *A.verticillata* was more frequent on the dunes. The Banksias had commonly reached diameters between 1–2 m before their recent decline. Between 1941 and 1987, the area occupied by open grassed dunes almost halved from 1875 ha to 977 ha, with the invasion of *L. laevigatum*. Much of the area remaining open in 1987 has been kept in that condition by slashing and the area with *B.integrifolia* and *L. laevigatum* increased from 22 ha in 1941 to 1347 ha in 1987 (Bennett 1993).

Changes following the removal of stock suggest that cattle browsing helped keep *L.laevigatum* seedlings suppressed until killed by later fires. Browsing also reduced other shrub species, particularly *Acacia longifolia*. Thus burning may have spread *B.integrifolia* regeneration from the unstable dunes into the grass covered swales, where small clumps and isolated trees survived later fires. Burning would also have assisted the regeneration of *Imperata cylindrica* and Kangaroo Grass *Themeda triandra* and explain the association that now exists between *Banksia integrifolia* and *T. triandra*. After the severe fire in 1951, burning to stimulate new growth for grazing was effectively discouraged. Burning ceased when the area was added to the National Park in 1969, although agistment continued until February 1992. With the exclusion of fire, regeneration of *Banksia* has been steady on the sandy soils regularly disturbed by cattle and feral animals. Groves of trees with a more shrubby habit developed but these have succumbed to a disorder whose origin remains obscure (Bennett 1993).

Fenced plots indicate that a grassland or woodland dominated by *Allocasuarina* or *Banksia* with a ground stratum of *Themeda*, *Imperata* and *Stipa*, may form on the alkaline sands of the isthmus, according to the presence of grazing, browsing and the frequency of fire (Chesterfield *et al.* 1995). Coastal scrub and trees other than eucalypts persist on unstable dunes, providing the populations which can expand under different burning, grazing and browsing regimes. One combination of over-grazing and browsing without burning, followed by a cessation of browsing, leads to a decline in fire-promoted grasses, an increase in unpalatable graminoids and shrubs eg. *Baumea juncea* and Silky Guinea-flower *Hibbertia cericea,* and a dramatic increase in the secondary succession of scrub, evident on the dunes and swales in 1971 (Turner and Ashton 1971). A similar change is presently occurring on the airstrip now that cattle agistment has ceased.

***Dieback of* Banksia integrifolia**

Dieback of *B. integrifolia* first became evident as a widespread and general disorder in the spring and summer of 1986. The pollen record suggests that fluctuations in *B.integrifolia* populations have occurred over a long period, commencing well before settlement (Hope 1974). The most recent contraction may, therefore, be part of a cycle. It is possible that the exclusion of fire has caused a change in soil properties (Bennett 1993). The current decline follows an extended fire-free period, and this factor cannot be discounted. Symptoms first appeared in early 1980 before the severe drought in 1982/83 but it was not until 1986 that these extended into cause for concern. The disorder appeared as branches became chlorotic, showing a grey green discoloration and eventually tree death followed. The decline was patchy with apparently healthy trees adjacent to others in an advanced state of decline. All age classes were affected although plants less than one metre commonly appeared more healthy. Although occasional individuals of other species have died, their deaths do not appear connected with the general disorder apparent in Banksia.

Tests of diseased stems and roots and associated soil failed to recover root destroying pathogens. No foliage pathogens that could be responsible were found. Tests for nematodes were positive but the numbers were considered insufficient to explain the severity and widespread nature of the disorder.

Populations of *B.integrifolia* occur on both acidic and alkaline soils of varying

fertility between Capes Schanck and Conran. There was no evidence to suggest that the soils at Yanakie were beyond the species range, and declining trees did not differ appreciably from healthy trees in nutritional status. However apparent symptoms could be reproduced in seedlings grown in affected soil in the glasshouse. Chlorosis in a pot trial was strongly correlated with levels of iron and manganese and the dilution of soil from a healthy site with that from an unhealthy site markedly increases chlorosis and reduced root growth, particularly of proteoid roots (Bennett 1993). Proteoid roots are clusters of rootlets and adsorption hairs on the lateral roots in the upper soil horizons, greatly increasing the surface area. They function for a short period during winter and spring in adverse environments for the uptake of nutrients (Purnell 1960). Their effective functioning is clearly important in maintaining the vigour of *B.integrifolia*, and many other heathland proteaceous species, for example *Hakea sp.* which do not form mycorrhizal associations.

Conclusion

Deliberate management of the biota in Wilsons Promontory National Park has been limited since its reservation in 1898. Survey and research conducted in the park from that date has contributed significantly to an understanding of the biological pattern, particularly the response to fire and the fire regime. During this period the ecosystems of the park have not remained static, some have changed dramatically, particularly those most influenced by the policies of fire protection.

A fire protection policy impacts upon the fire regime and incurs a concomitant responsibility for ecological burning. Implementing fire regimes appropriate to the different communities is challenging. Park rangers have rarely been involved in research conducted in the park and the responsibility for assessing and implementing results has not been clear. The outcome has been to adopt a philosophy which trusts *'in the self regulatory properties of nature to maintain the status quo'*, particularly if there are doubts about the best course to follow (Lamprey 1974). This avoids the deliberate planning commonly given to the cultural and recreational assets of national parks. In contrast, habitat management maintains a focus on biological conservation (Good 1981), a primary purpose of national parks.

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Appendix

Rock type /Landform	Formation	Species
Granite		
Montane and hilly	Rocky dry heath	Bush-pea *Pultenaea mollis* Kunzea, White *Kunzea ambigua*
	Headland woodland	She-oak, Drooping *Allocasuarina verticillata*
	Damp heath	Grass-tree, Austral *Xanthorrhoea australis* Mat-rush, Wattle *Lomandra filiformis* Heath, Blunt-leaf *Epacris obtusifolia* Paper-bark, Scented *Melaleuca squarrosa* She-oak, Swamp *Allocasuarina paludosa* Swamp-heath, Pink *Sprengelia incarnata* Tea-tree, Prickly *Leptospermum continentale*
	Woodland	Bracken, Austral *Pteridium esculentum* Grass, Wire *Tetrarrhena juncea* Banksia, Hairpin *Banksia spinulosa* Flower, Guinea *Hibbertia aspera* Moses, Prickly *Acacia verticillata* Needlewood, Bushy *Hakea decurrens* Peppermint, Shining *Eucalyptus willisii* Stringybark, Messmate *Eucalyptus obliqua*
Foothill	Damp forest	Fern, King *Todea barbara* Ground-fern, Common *Calochlaena dubia* Saw-sedge, Red-fruit *Gahnia sieberana* Sedge, Tall *Carex appressa* Sword-sedge, Tall *Lepidosperma elatius* Tree-fern, Hard *Cyathea australis* Tree-fern, Soft *Dicksonia antarctica* Water-fern, Fishbone *Blechnum nudum* Currant-bush, Prickly *Coprosma quadrifida*

Granite cont.		
Foothill	Damp forest cont.	Pomaderris, Hazel *Pomaderris aspera* Stringybark, Brown *Eucalyptus baxteri* Stringybark, Messmate *Eucalyptus obliqua* Stringybark, Yellow *Eucalyptus muelleriana*
Upper slopes	Wet forest	Fern, Finger *Grammitis billardierei* Hook-sedge, Delicate *Uncinia tenella* Ash, Mountain *Eucalyptus regnans* Blackwood *Acacia melanoxylon* Blanket-leaf, *Bedfordia arborescens* Currant-bush, Prickly *Coprosma quadrifida* Daisy-bush, Musk *Olearia argophylla* Pomaderris, Hazel *Pomaderris aspera* Spleenwort, Mother *Asplenium bulbiferum* Stringybark, Messmate *Eucalyptus obliqua*
Flat sheltered valleys	Rainforest	Shield-fern, Mother *Polystichum proliferum* Water-fern, Fishbone *Blechnum nudum* Water-fern, Hard *Blechnum wattsii* Beech, Myrtle *Nothofagus cunninghamii* Blackwood *Acacia melanoxylon* Gum, Blue *Eucalyptus globulus ssp. globulus* Lilly-pilly *Acmena smithii* Sassafras, Southern *Atherosperma moschatum*
Siliceous		
Flat sand sheets ***Undulating dunes***	Dry heath	Sheoak *Allocasuarina media* Sheoak *Allocasuarina paradoxa* Tea-tree, Prickly *Leptospermum continentale* Tea-tree, Silky *Leptospermum myrsinoides*
	Damp heath	Grass-tree, Austral *Xanthorrhoea australis* Rope-rush, Spreading *Empodisma minus* Heath, Blunt-leaf *Epacris obtusifolia* Paper-bark, Scented *Melaleuca squarrosa* Swamp-heath, Pink *Sprengelia incarnata* Tea-tree, Prickly *Leptospermum continentale*
	Wet heath	Button-grass *Gymnoschoenus sphaerocephalus* Cord-sedge, Tassel *Restio tetraphyllus* Rapier-sedge, Common *Lepidosperma filiforme*
Older dunes	Woodland	Showy Bossiaea *Bossiaea cinerea* Banksia, Saw *Banksia serrata* Stringybark, Messmate *Eucalyptus obliqua*
Low-lying areas & coast	Saline herbfield	Club-rush, Knobby *Isolepis nodosa* Rush, Sea *Juncus kraussii* Brookweed, Creeping *Samolus repens* Cellery, Sea *Apium prostratum* Glasswort, Beaded *Sarcocornia quinqueflora* Goosefoot, Glaucose *Chenopodium glaucum* Karkalla *Carpobrotus rossii* Selliera *Selliera radicans*
Margin to Corner Inlet		
	Closed scrub	Saw-sedge, Red-fruit *Gahnia sieberana* Saw-sedge, Tall *Gahnia clarkei* Sedge, Brickmakers *Gahnia grandis* Sword-sedge *Lepidosperma elatius* Sword-sedge, Variable *Lepidosperma laterale* Paper-bark, Scented *Melaleuca squarrosa* Paper-bark, Swamp *Melaleuca ericifolia*
	Rushland & herbfield	Arrowgrass, Streaked *Triglochin striatum* Couch, Salt *Sporobolus virginicus* Club-rush, Knobby *Isolepis nodosa* Grass, Mat *Hemarthria uncinata* Salt Grass, Australian *Distichlis distichophylla* Twine-rush, Coarse *Leptocarpus brownii* Lobelia, Angled *Lobelia alata* Marsh-flower, Running *Villarsia reniformis* Pennywort *Hydrocotyle sibthorpioides*

Siliceous cont. ***Margin to Corner Inlet*** **cont.**	Wet closed heath	Coral Fern, Pouched *Gleichenia dicarpa* Twig-rush, Square *Baumea tetragona*
	Wet closed heath	Paper-bark, Scent *Melaleuca squarrosa* Tea-tree, Prickly *Leptospermum continentale*
	Closed scrub	Sword-sedge, Pithy *Lepidosperma longitudinale* Twig-rush, Bare *Baumea juncea* Twig-rush, Soft *Baumea rubinginosa* Marsh-flower, Running *Villarsia reniformis* Paper-bark, Scented *Melaleuca squarrosa* Paper-bark, Swamp *Melaleuca ericifolia*
	Swamp sedgeland	Bog-rush, Zig-Zag *Schoenus brevifolius* Cumbungi, Broad-leaf *Typha orientalis* Scale-rush, Common *Lepyrodia muelleri* Sword-sedge, Pithy *Lepidosperma longitudinale* Tongue-orchid, Small *Cryptostylis leptochila* Twig-rush, Soft *Baumea rubinginosa* Bog Gum *Eucalyptus kitsoniana*
	Shrub grassland	Bog-rush *Schoenus carsei* Cumbungi, Broad-leaf *Typha orientalis* Saw-sedge, Chaffy *Gahnia filum* Saw-sedge, Coast *Gahnia trifida* Twig-rush, Bare *Baumea juncea* Twig-rush, Leafy *Cladium procerum* Tea-tree, Woolly *Leptospermum lanigerum*
	Shrubland-tall shrubland	Arrowgrass, Streaked *Triglochin striatum* Cellery, Sea *Apium prostratum* Dodder, Golden *Cuscuta tasmanica* Nettle, Scrub *Urtica incisa* Parsnip, Water **Berula erecta* Pennywort *Hydrocotyle sibthorpioides* Tea-tree, Woolly *Leptospermum lanigerum*
Corner Inlet	Mangroves	Mangroves *Avicennia marina* subsp *australasica*
Calcareous		
Foreshore	Grassland	Grass, Marram **Ammophilla arenaria* Saltbush, Coast *Atriplex cinerea* Spinifex, Hairy *Spinifex sericeus* Fan-flower, Dune *Scaevola calendulacea* Karkalla *Carprobrotus rossii* Spurge, Sea **Euphorbia paralias*
Hinterdune	Scrub	Beard-heath, Coast *Leucopogon parviflorus* Boobialla, Common *Myoporum insulare* Correa, White *Correa alba* Daisy-bush, Coast *Olearia axillaris* Everlasting, Coast *Ozothamnus turbinatus* Saltbush, Seaberry *Rhagodia candolleana* Tea-tree, Coast *Leptospermum laevigatum* Wattle, Sallow *Acacia longifolia*
Pleistocene dune	Woodland	Bracken, Austral *Pteridium esculentum* Apple, Kangaroo *Solanum aviculare* Banksia, Coast *Banksia integrifolia* Elderberry, White *Sambucus gaudichaudiana* Spinach, Bower *Tetragonia implexicoma*
Recent dunes	Woodland scrub	Banksia, Coast *Banksia integrifolia* Beard-heath, Coast *Leucopogon parviflorus* Bursaria, Sweet *Bursaria spinosa* Pomaderris, Coast *Pomaderris oraria* Sheoak, Drooping *Allocasuarina verticillata* Tea-tree, Coast *Leptospermum laevigatum* Wattle, Sallow *Acacia longifolia*
Dune swales	Woodland grassland	Grass, Blady *Imperata cylindrica* Grass, Kangaroo *Themeda triandra* Banksia, Coast *Banksia integrifolia* Tea-tree, Coast *Leptospermum laevigatum*

* introduced

Granite Outcrop Vegetation of Wilsons Promontory

John T. Hunter[1]

Abstract
Granite outcrops are a conspicuous component of Wilsons Promontory and it is here that some of the first Australian work on the communities that occur on granite outcrops was undertaken. The vegetation on outcrops is unique and its dynamics are often different to those of the surrounding communities and therefore require different management strategies. Further research is required on the outcrop vegetation of Wilsons Promontory to enable appropriate management decisions to be made to ensure their continued survival. (*The Victorian Naturalist* **115** (6), 1988, 322-325).

Introduction

Granite is the main component of continents. Much of Wilsons Promontory consists of a Devonian granite batholith surrounded by Cenozoic sediments (Ashton and Webb 1977; Hill 1994). Large positive relief landforms such as bornhardts (steep sided island mountains), nubbins (boulder piles) and castle koppies (domes with pronounced fractures) along with many minor forms such as boulders, flared slopes (such as wave rock), rock basins (surface hollows and pits) and tafoni (basal hollows) (Twidale 1980; Hill 1994; Hill 1996; Campbell 1997) form conspicuous features of Wilsons Promontory (Ashton and Webb 1977; Hill 1994). Although rarely defined, granite outcrops are often composed of the larger landforms that form sizeable, isolated intrusions into the landscape (Ornduff 1987). The flora on outcrops is often considered to be insular and to consist of physiognomically and floristically well-defined habitats (Hopper *et al.* 1997; Porembski *et al.* 1997; Hunter 1998). Granite outcrops are part of ancient and stable landscapes (Bussell and James 1997; Porembski *et al.* 1997) that provide clearly delimited systems suitable for testing hypotheses on the maintenance of biodiversity (Porembski *et al.* 1994).

Within Australia, very little work has been carried out, until recently, on the communities found on granite outcrops and because of their isolated and relatively small size they have been ignored, or lumped within descriptions of other structurally similar communities such as heaths. They do, however, form a distinctive component of the flora of any area and management issues of outcrop vegetation are often dissimilar to those of the communities that envelop or abut them (Hunter *et al.* 1998), or in which they are often placed in broad scale mapping. The investigation of the flora of granite outcrops at Wilsons Promontory and surrounding islands is some of the earliest specific research into these unique communities to have occurred within Australia (Gillham 1961; Hope and Thompson 1971; Norman 1971; Webb 1972; Aston and Webb 1977; Norman and Brown 1979; Norman *et al.* 1980; Meagher 1996).

Floristics

Rock outcrops occur between sea level and 800 m altitude at Wilsons Promontory. Community descriptions and changes are given fully by Ashton and Webb (1977) with summaries included in Beadle (1981) and Conn (1993). The following represents an account of some of the major vegetation components described by these authors. The change in altitude, and removal from the effects of the sea spray significantly affects the vegetation on rock outcrops.

Near the coastal fringe, mosses are unable to grow. However, crustose lichens such as *Caloplaca marina* and *Parmelia conspersa* are common. A few succulents occur here such as Rounded Moon-flower *Disphyma crassifolium,* Ross' Moon-flower *Carpobrotus rossii,* Variable Groundsel *Senecio lautus* (succulent form) and the salt marsh taxa Creeping Brookweed *Samolus repens* and Samphire Sarcocornia *Sarcocornia quinqueflora*. In protected sites, heaths of Drooping Sheoke *Allocasuarina verticillata* and Prickly Tea-tree *Leptospermum continentale* occur. Generally, however, below 400–500 m, on

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areas with soil development, but above the coastal fringe, heaths are dominated by White Kunzea *Kunzea ambigua* with Common Heath *Epacris impressa*, Large-leaf Bush Pea *Pultenaea daphnoides*, Tall Sundew *Drosera peltata* subsp. *auriculata* and some succulent annuals such as *Crassula sieberiana*.

Above 400-500 m (but also down to 300 m) Lemon Bottlebrush *Callistemon pallidus* dominates with associated species such as *Leptospermum continentale*, *Epacris impressa* and *Olearia stellulata*. At these altitudes mosses such as *Grimmia laevigata*, *Campylopus bicolor* and *Rhacomitrium* spp. occur. In some sites amongst the protection of rocks, wind-shorn Myrtle Beech *Nothofagus cunninghamii* with *Monotoca elliptica*, *Epacris impressa*, *Callistemon pallidus*, Mountain Pepper *Tasmannia lanceolata* and *Olearia stellulata* can be found.

Discussion

The vegetation on outcrops is considered to be complex and highly variable (Ashton and Webb 1977). The scale of observation has an important role to play in the delineation of differences in vegetation (Hunter and Clarke 1998). On a local scale, an individual outcrop may have various topographical features that affect what can physically grow. For example, in minor crevices only bryophytes may be found (e.g. *Campylopus bicolor*, *Grimmea laevigata*, *Jamesoniella colorata* and *Rhacomitrium crispulum*), shallow basins may only support herbs (e.g. Pink Purslane *Calandrinia calyptrata*, Bluebell spp. *Wahlenbergia* spp., Small Pennywort *Hydrocotyle callicarpa* and Tiny Club-rush *Isolepis marginata*) and deeper stepped crevices such as 'Babylonian Gardens' (York Main 1997) may support shrubs (e.g. *Kunzea ambigua*, *Leptospermum continentale* and *Callistemon pallidus*) or even trees (e.g. Messmate *Eucalyptus obliqua* or *Nothofagus cunninghamii*). Ashton and Webb (1977) attributed the variation they saw in vegetation patches at Wilsons Promontory to this irregular nature of rock outcrops. However, on a regional scale, such as over the entire promontory, other factors affect changes in outcrop vegetation such as climate and larger landscape features. Ashton and Webb (1977) found that the major vegetation changes between outcrops at Wilsons Promontory were due to features such as altitude, aspect and proximity to the ocean (see floristics section above).

At an intermediate scale, however, on relatively the same topography, there is an almost random difference between vegetation patches both structurally and in terms of dominants. These changes can be attributed to the harsh environmental conditions on outcrops, their 'island' nature and the small population size of any particular species. These attributes of outcrop vegetation patches make establishment an unlikely event and periodic extinction likely. Ashton and Webb (1977), though concentrating on the successional aspects of such dynamics, touched on some of these matters and noted that shrub zones, destroyed by fire, had not regenerated after fires, and that drought had produced a similar effect in killing both trees and shrubs. Ashton and Webb (1977) followed the germination of seedlings over a period of several years and found that even when germination occurred, survival from one year to the next was unlikely.

Dispersal to an outcrop is a chance occurrence. Once a seed finds its way to an outcrop, germination requirements may not be met before the seed dies, and even if germination occurs, the chances of establishment are very low. Even after establishment, the likelihood of extinction due to chance events, such as fire, drought or even heavy rains, is high because of the small population sizes. This in itself can lead to significant local changes in structure and floristics between individual patches. Furthermore, changes can also occur after certain taxa become established. For instance a shrub such as *Kunzea ambigua* or *Leptospermum continentale*, once established, can completely change the local microclimate or dominate available space or resources. As well, Ashton and Webb (1977) discuss how shrubs may, with their combined litter fall, adversely affect nearby mosses and lichens. In addition, if these shrubs are lost by local extinction, humus development can be quickly eroded, setting back

structural development, for example by changing from a heath to a herbfield.

The balance between establishment and extinction as described above is also of relevance to the impact of visitors. The effects of worn trails, the mechanical damage caused to shrubs and to bryophyte and lichen mats, or the increase of nutrients and changes in pH associated with organic litter (such as orange peels, left over sandwiches, etc.) may be more acutely felt in these communities. Changes caused by visitor impacts may not be easily remedied and the flora may take years or even decades to recover.

Outcrop communities are generally collectively lumped with other shrubland or heath communities (e.g. Wescott 1995) although this placement is often inappropriate from a management perspective. For instance, 'heaths' in general are thought to regenerate well after fire, having a high proportion of resprouting taxa. Russell and Parsons (1978) showed that 73% of shrub species in 'heaths' at Wilsons Promontory were able to regenerate from resprouting. These researchers showed that fire intervals of 10 years were likely to cause only minor changes in floristics and that inter-fire periods greater than this would cause a decline in species richness. The outcrop 'heaths' of Wilsons Promontory are unlikely to fit within these general conclusions since research on outcrop communities has shown that they are likely to be refugial areas for fire-sensitive taxa. Hopper *et al.* (*unpubl. data* reported in Hopper *et al.* 1997) have shown that 77% of taxa on granite communities in Chiddarcooping Nature Reserve in Western Australia were obligate seeders. A similar result has been obtained from fire research plots on granite outcrops in Bald Rock National Park in New South Wales by the author (Hunter *in prep.*). This appears to be a universal feature of outcrop communities across the country, and anecdotal evidence given by Ashton and Webb (1977) supports these findings for Wilsons Promontory. This does not mean that fire should be permanently excluded from outcrops but that the inter-fire periods should be on a much longer time scale than for surrounding heathlands. Some primarily outcrop-restricted taxa with long-lived seed banks have been shown to require disturbances such as fire to aid regeneration (Hunter 1995, 1998a, 1998b; Hunter *et al.* 1998).

Conclusion

Wilsons Promontory is a special place, and the extensive granite outcrop communities enhance this quality. The usually small and scattered nature of granite outcrops and their inaccessibility often make management based on zoning impractical (Main 1997). These outcrop communities require specialised management (Hunter *et al.* 1998) as they are different from those that surround them, and lumping them into other similarly structured ones is inappropriate and may have negative consequences. The outcrops at Wilsons Promontory need separate consideration in management issues and require specific research especially in terms of colonisation, establishment and fire responses. Wilsons Promontory was one of the first areas in Australia to have its outcrop communities recognised as being distinct, and hopefully will also be one of the first places in which the dynamics of these communities are understood and management priorities are specifically written for them.

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Additions to the Bryophyte Flora of Wilsons Promontory

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Abstract

This paper reports on recent bryophyte surveys in Wilsons Promontory National Park and presents an updated list of species, comments on certain species of interest, and notes on the conservation status of species and areas of bryological significance. (*The Victorian Naturalist* **115** (6), 1998, 325-330).

Introduction

A recent summary of the known bryophyte flora of Wilsons Promontory was published in *The Victorian Naturalist* in 1996 (Meagher 1996). This summary was based on herbarium records and published literature, supplemented by a survey of 74 sites during 1994 and 1995. Since that time, the authors have conducted similar surveys at 18 additional sites and reviewed other available records. This paper presents the results of this additional work.

Methodology and nomenclature

The survey methodology used was as described in Meagher (1996). Collections were made under research permits issued by the National Parks Service (1995–96) and by the Parks, Flora and Fauna Division, Department of Natural Resources and Environment (1996–98). Specimens representing new records for the area have been lodged with the National Herbarium, Melbourne. Determinations were made by the authors.

Nomenclature follows the Flora Information System of the Arthur Rylah Institute for Environmental Research (ARI 1998). Because Scott and Stone (1976) and Scott (1985) are still the major references on bryophytes in southern Australia, the following changes to nomenclature since their publication are noteworthy (Table 1).

Significant records

The recent surveys have provided the following significant records shown in

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Table 1. The changes to nomenclature since Scott and Stone (1976) and Scott (1985).

Mosses	
Name in Scott and Stone (1976)	***Name in current use***
Barbula australasiae	*Trichostomopsis australasiae* (Hook.f. & Grev.) H.Rob.
Barbula torquata	*Didymodon torquatus* (Tayl.) Catcheside
Bryum billardierei	*Rosulabryum billardierei* (Schwaegr.) Spence
Camptochaete gracilis	*Fallaciella gracilis* (Hook.f. & Wilson) Crum
Campylopus pallidus	*Campylopus pyriformis* (Schultz) Brid.
Catagonium politum	*Catagonium nitens* (Brid.) Card. subsp. *nitens*
Dicranoloma billardieri var. *robustum*	*Dicranoloma robustum* (Hook.f. & Wils.) Par.
Eurhynchium muriculatum	*Rhynchostegiella muriculatum* (Hook.f. & Wils.) Broth.
Fissidens pungens	*Fissidens curvatus* Hornsch.
Fissidens tenellus	*Fissidens serratus* var. *serratus* K. Muell. hal.
Fissidens vittatus	*Fissidens megalotis* Schimp. ex K. Muell. hal.
Funaria gracilis	*Entosthodon subnudus* (Tayl.) Fife var. *gracilis* (Hook.f. & Wils.) Fife
Funaria microstoma	*Funaria salsicola* K. Muell. hal.
Grimmia apocarpa	*Schistidium apocarpum* (Hedw.) B.S.G.
Macromitrium tenue	*Macrocoma tenue* (Hook. & Grev.) Vitt ssp. *tenue*
Macromitrium weymouthii	*Macromitrium microstomum* (Hook. & Grev.) Brid.
Rhizogonium mnioides	*Pyrrhobryum mnioides* (Hook.) Manuel
Rhizogonium parramattense	*Pyrrhobryum parramattense* (K. Muell.) Manuel
Sematophyllum amoenum	*Rhapidorrhynchium amoenum* (Hedw.) Fleisch.
Tortella calycina	*Barbula calycina* Schwaegr.
Liverworts	
Name in Scott (1985)	***Name in current use***
Lethocolea squamata	*Lethocolea pansa* (Tayl.) G.A.M. Scott & K. Beckmann

Table 2. New records for Wilsons Promontory.

Mosses	
Bryum laevigatum	*Fissidens megalotis*
Campylopus incrassatus	*Fissidens rigidulus*
Dawsonia longiseta	*Macromitrium ligulaefolium*
Fissidens integerrimus	*Pottia davalliana*
Liverworts	
Acrobolbus cinerascens	*Metzgeria grollei*
Acrobolbus concinnus	*Plagiochila strombifolia*
Acrochila biserialis	*Podomitrium phyllanthus*
Acromastigum colensoanum	*Riccardia cochleata*
Chiloscyphus limosus	*Riccardia colensoi*
Diplophyllum obtusifolium	*Riccia crystallina*
	Sphaerocarpos texanus
Leptophyllopsis laxa	*Telaranea patentissima*

Table 2 which are new records for Wilsons Promontory.

Other significant records

Arthur Thies has kindly provided lists of species he has collected on the Promontory, which include the following first collections for the Park (Table 3). Those marked with an asterisk were incorrectly stated to be first records in Meagher (1996).

Table 3. New records for Wilsons Promontory collected by Arthur Thies.

Mosses	
Bartramia papillata	*Hypnum chrysogaster*
Liverworts	
*Frullania rostrata**	*Metzgeria decipiens**
Hepatostolonophora paucistipula	*Metzgeria densiseta*
Lophocolea novaezelandiae	*Nephelolejeuena hamata*
	Riccardia wattsiana

Discussion

The new records bring the total number of moss species recorded for the Promontory to 149, and the number of liverwort species to 85 (see Appendix). Five mosses have not been recorded on the Promontory since 1960; one of these, *Schistidium apocarpum*, has not been recorded from the Promontory since 1853.

Notes on particular species:

Aneura rodwayi - Meagher (1996) took Mueller's '*Riccardia pinguis*' (Garnet 1971) to be *Aneura alterniloba*. However, Arthur Thies (*pers. comm.*) considers it to be *Aneura rodwayi*, and we have therefore included that species in our list.

Campylium polygamum - This species was found by G.A.M. Scott at a single site in the Park, in a *Gahnia* swamp on Corner Inlet. It had been recorded for the first time in Victoria by Ms E. Leach in 1972, probably near Yanakie Beach or

Red Bluff Beach, outside the Park. Our recent search of that area, which has been substantially developed since the 1970s, failed to find the species. The location within the Park is thus the only known current location of this species in Victoria, and is therefore of some botanical significance.

Campylopus incrassatus - This species may have been overlooked in the past, as it is superficially similar to *C. introflexus* and *C. clavatus*. The straight hairpoints and red tomentum are a warning to investigate further. Microscopic examination shows hyaline basal cells combined with quadrate-rectangular upper laminal cells and an unusual leaf cross-section. It is known at present from only one site on the Promontory.

Dawsonia longiseta - This is a widespread species throughout south-eastern Australia and is probably common but overlooked on the Promonotory, where the only known population consists of perhaps thirty plants.

***Drepanocladus aduncus* s.l.** - This species has been found to be common in freshwater creeks and soaks along the western coast of Corner Inlet.

Fissidens australiensis*, *F. tenellus - Collections of these species from Sealers Cove by Mueller were not recorded in Garnet (1971), and thus not in Meagher (1996). They are listed in Mitten (1882) (*F. australiensis* as *F. purpusillus*).

Fissidens megalotis - We have previously thought of this as a species of drier regions. It was found in the grounds of the lighthouse complex, and might be an accidental introduction.

Hypnodendron comosum - This is the first record of this species from the Promontory since Leslie (1925).Mueller's collection from Sealers Cove in 1853 was not mentioned in Garnet (1971).

Lepidolaena clavigera*, *L. magellanica - Listed by Gottsche (1880) for Wilsons Promontory, but we have no doubt that these were errors for *Gackstroemia weindorferi*: see Scott (1985), p 168–9.

Lejeunea gunniana - The species called by this name in Meagher (1996) is *Lejeunea drummondii*.

Macromitrium hemitrichiodes - A specimen in MEL collected by Mueller at Sealers Cove is ascribed to this species. Pending a review of the specimen, we accept it as a good record.

Macromitrium ligulaefolium - This record fills a large gap in the known distribution of the species. In Victoria it is otherwise known only from the Otways and far eastern Victoria (Vitt and Ramsay 1985).

Macromitrium longirostre - Vitt and Ramsay (1985) report this species from Wilsons Promontory, and we accept it as a good record. If they are correct in their assertion that a specimen from the Sydney region is a false record, then Wilsons Promontory represents the northernmost and significantly disjunct occurrence of the species (the nearest other record being from King Island).

Pallavicinia xiphioides - This species (as *P. spinosa*) was listed in Garnet (1971) and Meagher (1996) on account of a specimen collected from Mt Oberon by S. Dücker. However, the original specimen, which we discovered in the field collection in the University of Melbourne field station at Tidal River, is *Symphyogyna podophylla*.

Pottia davalliana - This moss tends to grow in disturbed places, especially moist, compacted soil. Like most species of *Pottia* it is inconspicuous except when in fruit.

Riccardia multifida - This species, recorded in Garnet (1971) and included in the list in Meagher (1996), is otherwise known only from the northern hemisphere and thus seems a doubtful record. In the absence of any substantiating evidence we have chosen to delete it from the list of species.

Riccia crystallina - See notes for *Sphaerocarpos texanus*.

Sphaerocarpos texanus - Perhaps a recent introduction to Australia from the northern hemisphere, this is typically a species of disturbed habitats. It is not surprising to find it with *Riccia crystallina* on bare soil around the Tidal River camping ground.

Sematophyllum leucocytus - Arthur Thies's collection of this species on Mt Oberon in 1996 might have been the first on the Promontory, since Mueller's 1853 collection attributed to the Promontory by Garnet (1971) could have been from another area (Meagher 1996). Curiously,

Table 4. Species considered to be rare within Wilsons Promontory National Park. Species considered also to be rare or vulnerable in Victoria are indicated by a hatch (#).

Mosses		
Bartramia papillata	var. *gracilis*	*Macromitrium logirostre*#
Bartramidula pusilla	*Eriopus brownii*#	*Macromitrium microstomum*
Bryum affine	*Fissidens australiensis*	*Philonotis scabrifolia*
Bryum aff. *alpinum*#	*Fissidens integerrimus*#	*Pohlia nutans*
Bryum laevigatum	*Fissidens megalotis*	*Pottia davalliana*
Campylium polygamum#	*Fissidens rigidulus*	*Rhynchostegiella muriculatum*
Campylopus incrassatus	*Goniobryum subbasilare*	*Schistidium apocarpum*
Cratoneuropsis relaxa	*Macromitrium archeri*	*Sematophyllum leucocytus*
Dawsonia longiseta	*Macromitrium hemitri-choides*#	*Sphagnum cristatum*
Entosthodon subnudus	*Macromitrium ligulaefolium*#	
Liverworts		
Acrobolbus cinerasacens#	*Frullania deplanata*	*Podomitrium phyllanthus*
Acrobolbus concinnus	*Frullania pentapleura*	*Radula compacta*
Acrochila biserialis	*Hepatostolonophora paucistipula*	*Riccardia colensoi*
Aneura rodwayi#	*Lepidozia obtusiloba*	*Riccardia wattsiana*
Chiloscyphus limosus	*Metzgeria densiseta*	*Riccia crystallina*
Diplasiolejeunea plicatiloba	*Metzgeria grollei*	*Sphaerocarpos texanus*
Fossombronia alata#	*Nephelolejeunea hamata*	*Telaranea patentissima*

Mitten (1882) does not record the species as a Muellerian collection, despite Mueller having reviewed Mitten's paper and added his own records.

For a discussion of a number of other records from the literature, see Meagher (1996). Mosses and liverworts recorded from Wilsons Promontory are listed in the appendix.

Conservation status of species

Little is known of the conservation status of most bryophytes in Australia because of the general lack of distribution and abundance data. However, Scott *et al.* (1997) provides a list of nationally threatened bryophytes, none of which is known from Wilsons Promontory. The published lists of species considered rare or threatened in Victoria (Stone 1989; Scott 1989) are outdated. However, a review of the status of Victorian bryophytes was undertaken in 1997 by an expert group convened by the Department of Natural Resources and Environment. Although this review remains unpublished, it is the basis for the Victorian conservation status assigned to some species in Table 4.

Seven mosses and three liverworts known from Wilsons Promontory are considered to be rare in Victoria; we also consider 26 mosses and 23 liverworts to be locally rare because they have not been recorded from more than one locality on the Promontory in the last 50 years (Table 4). This latter category perhaps reflects a lack of data as much as the true conservation status of some of these species, and the 'locally rare' status of some species will no doubt change as further records are gathered. However, the 'precautionary principle' must apply to the conservation of these species in the absence of further records. Changes in management practices and the development of facilities within the park will need to take into account the conservation of these species, to avoid losing significant components of the Park's biodiversity.

Bryologically significant areas within the Park

From our surveys we suggest that the following areas are significant for their bryological flora, and that the management of these areas be sympathetic to their scientific significance. A number of specific sites that are also of significance are not mentioned here to protect their integrity.

Roaring Meg Creek catchment - This catchment, with a generally southerly aspect, supports a highly significant bryophyte flora that has clear affinities with the bryophyte flora of Flinders Island and Tasmania. A thorough survey of the catchment would help to determine its full significance.

Chinamans Creek catchment - This catchment supports numerous species not yet found elsewhere in the Park, and is also highly significant for fungi (B.A. Fuhrer,

pers. comm.). The protection afforded by the catchment's location within a declared wilderness area appears to be adequate at present, but fire is a constant threat.

Headwaters of Blackfish Creek - This area appears to represent the remnants of *Nothofagus cunninghamii* rainforest, and supports numerous rainforest bryophytes not yet found elsewhere in the Park.

Sealers Swamp - This area was the site of Mueller's original collections in the 1850s, and has not been well surveyed. We consider it to be of substantial scientific and historical significance and the site should be managed with this in mind.

Western coast of Corner Inlet - This coast includes numerous freshwater soaks, swamps and creeks which support an unusual meld of bryophyte flora, including species otherwise considered to be typical of wet forest. *Campylium polygamum* is a particularly significant species in this area.

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Appendix

Mosses recorded from Wilsons Promontory National Park

Achrophyllum dentatum
Acrocladium chlamydophyllum
Atrichum androgynum
Barbula calycina
Barbula crinita
Bartramia papillata
Bartramidula pusilla
Brachythecium albicans
Brachythecium rutabulum
Brachythecium salebrosum
Breutelia affinis
Bryum affine
Bryum sp. aff. *alpinum*
Bryum argenteum
Bryum blandum
Bryum campylothecium
Bryum capillare
Bryum chrysoneuron
Bruym crassum
Bryum dichotomum
Bryum laevigatum
Bryum pachytheca
Calyptogon mnioides
Camptochaete arbuscula
Campylium polygamum
Campylopus australis
Campylopus bicolor
Campylopus clavatus
Campylopus incrassatus
Campylopus introflexus
Campylopus pyriformis
Catagonium nitens ssp. *nitens*
Ceratodon purpureus

Mosses recorded from Wilsons Promontory National Park cont.

Conostomum pusillum
Cratoneuropsis relaxa
Cyathophorum bulbosum
Dawsonia longiseta
Dawsonia superba
Dicnemoloma pallidum
Dicranoloma billardieri
Dicranoloma dicarpum
Dicranoloma menziesii
Dicranoloma platycaulon
Dicranoloma robustum var. *setosum*
Dicranoweisia microcarpa
Didymodon torquatus
Distichophyllum crispulum
Distichophyllum microcarpum
Distichophyllum pulchellum
Ditrichum cylindricarpum
Ditrichum difficile
Drepanocladus aduncus
Echinodium hispidum
Entosthodon subnudus var. *gracilis*
Eriopus apiculatus
Eriopus brownii
Fallaciella gracilis
Fissidens asplenioides
Fissidens australiensis
Fissidens curvatus
Fissidens humilis
Fissidens integerrimus
Fissidens leptocladus
Fissidens megalotis
Fissidens oblongifolius
Fissidens pallidus
Fissidens rigidulus
Fissidens serratus var. *serratus*
Fissidens taylorii
Funaria hygrometrica
Funaria salsicola
Gigaspermum repens
Goniobryum subbasilare
Grimmia laevigata
Grimmia pulvinata
Grimmia tricophylla
Gymnostomum calcareum
Hedwigia ciliata
Hedwigia integrifolia
Holomitrium perichaetiale
Hymenodon pilifer
Hypnodendron comosum
Hypnodendron spininervium
Hypnodendron vitiense
Hypnum chrysogaster
Hypnum cupressiforme var. *cupressiforme*
Hypnum cupressiforme var. *lacunosum*
Hypnum cupressiforme var. *mossmanianum*
Hypopterygium rotulatum
Isopterygium limatum
Lembophyllum divulsum
Leptostomum inclinans
Leptotheca gaudichaudii
Leucobryum candidum
Lopidium concinnum
Macrocoma tenue ssp. *tenue*
Macromitrium archeri
Macromitrium hemitrichoides
Macromitrium ligulaefolium
Macromitrium longirostre
Macromitrium microstomum
Mittenia plumula
Orthodontium lineare
Orthotrichum tasmanicum
Papillaria flavolimbata
Philonotis scabrifolia
Philonotis tenuis
Pleuridium nervosum
Pogonatum subulatum
Pohlia nutans
Polytrichadelphus magellanicus
Polytrichum juniperinum
Pottia davalliana
Pseudoleskea imbricata
Ptychomitrium australe
Ptychomitrium mittenii
Ptychomnion aciculare
Pyrrhobryum mnioides
Pyrrhobryum parramattense
Racomitrium crispulum
Racopilum convolutaceum
Rhacocarpus purpurascens
Rhapidorrhynchium amoenum
Rhizogonium distichum
Rhizogonium novaehollandiae
Rhynchostegiella muriculatum
Rhyncostegium laxatum
Rhyncostegium tenuifolium
Rosulabryum billardierei
Sauloma tenella
Schistidium apocarpum
Sematophyllum homomallum
Sematophyllum jolliffii
Sematophyllum leucocytus
Sphagnum cristatum
Tayloria octoblepharum
Thamnobryum pumilum
Thuidium furfurosum
Thuidium sparsum
Tortella cirrhata
Tortula antarctica
Tortula muralis
Tortula papillosa
Trichostomopsis australasiae
Triquetrella papillata
Weissia controversa
Weymouthia cochlearifolia
Wijkia extenuata
Zygodon intermedius
Zygodon menziesii
Zygodon minutus

Liverworts recorded from Wilsons Promontory National Park

Acrobolbus cinerascens
Acrobolbus concinnus
Acrochila biserialis
Acromastigum colensoanum
Aneura alterniloba
Aneura rodwayi
Anthoceros laevis
Asterella drummondii
Balantiopsis diplophylla
Bazzania involuta
Cephaloziella exiliflora
Chaetophyllopsis whiteleggei
Cheilolejeunea mimosa
Chiloscyphus argutus
Chiloscyphus coalitus
Chiloscyphus echinellus
Chiloscyphus fissistipus
Chiloscyphus limosus
Chiloscyphus tridentatus
Cuspidatula monodon
Diplasiolejeunea plicatiloba
Diplophyllum obtusifolium
Fossombronia alata
Fossombronia intestinalis
Frullania clavata
Frullania deplanata
Frullania falciloba
Frullania pentapleura
Frullania probosciphora
Frullania monocera
Frullania rostrata
Gackstroemia weindorferi
Goebelobryum unguiculatum
Hepatostolonophora paucistipula
Hymenophyton flabellatum
Isostachis intortifolia
Jamesoniella colorata
Kurzia compacta
Kurzia hippurioides
Lejeunea drummondii
Lepidozia laevifolia
Lepidozia obtusiloba
Lepidozia ulothrix
Leptophyllopsis laxa
Lethocolea pansa
Lophocolea biciliata
Lophocolea gunniana
Lophocolea minor
Lophocolea muricata
Lophocolea novaezelandia
Lophocolea pallida
Lophocolea semiteres
Lophocolea villosa
Lunularia cruciata
Marchantia berteroana
Marsupidium surculosum
Megaceros gracilis
Metzgeria decipiens
Metzgeria densiseta
Metzgeria furcata
Metzgeria grollei
Nephelolejeunea hamata
Plagiochila fasciculata
Plagiochila retrospectans
Plagiochila strombifolia
Podomitrium phyllanthus
Radula buccinifera
Radula compacta
Riccardia aequicellularis
Riccardia bipinnatifida
Riccardia cochleata
Riccardia colensoi
Riccardia crassa
Riccardia wattsiana
Riccia crystallina
Schistochila lehmanniana
Siphonolejeunea nudipes
Sphaerocarpos texanus
Symphyogyna podophylla
Telaranea centipes
Telaranea patentissima
Trichocolea mollissima
Tylimanthus tenellus
Zoopsis argentea
Zoopsis leitgebiana

Dieback at Wilsons Promontory. Is the Battle Won?

Gretna Weste[1]

Abstract

Dieback disease of tree and understorey caused by the cinnamon fungus, *Phytophsthora cinnamomi*, was first observed in 1970 on the Vereker Spur. It was spread by the use of infested gravel on the road verges. The epidemic was monitored for 28 years and has recently declined. The vegetation has regenerated with full species diversity except on water-gaining sites such as near Lilly Pilly Gully. The recent dry seasons have suited the heathland species, but not the pathogen. Fresh outbreaks of disease were observed in 1998, and if spring and summer are warm and wet, epidemic disease may recur. (*The Victorian Naturalist* **115** (6), 1988, 331-336).

Introduction

In 1973 the dreaded dieback pathogen, *Phytophthora cinnamomi*, threatened to destroy 75% of the native vegetation at Wilsons Promontory, just as in the jarrah forests of Western Australia, leaving a graveyard impression of dead trees with sedge understorey. This pathogen has more than 2,000 host species, compared with the *Phytophthora* which causes potato blight only on potato and tomato, or the Dutch elm disease which attacks only elms. The pathogen is often called the Cinnamon Fungus, because it was first isolated from cinnamon trees in Sumatra.

Detection

In August 1970, diseased vegetation was observed on the northern slopes of the Vereker Range along a fire access road controlled by a locked gate. *Phytophthora cinnamomi* was isolated from the roots of trees and shrubs showing dieback of the branches and yellowing of the foliage These were growing in the open forests, woodlands, heathlands and swamps (Weste and Law 1972). The pathogen was never isolated from healthy plants. The site surrounded the junction of Millers Landing and Five Mile roads. The dieback problem had come to Victoria, first to the Brisbane Ranges, Far East Gippsland, and now to Wilsons Promontory.

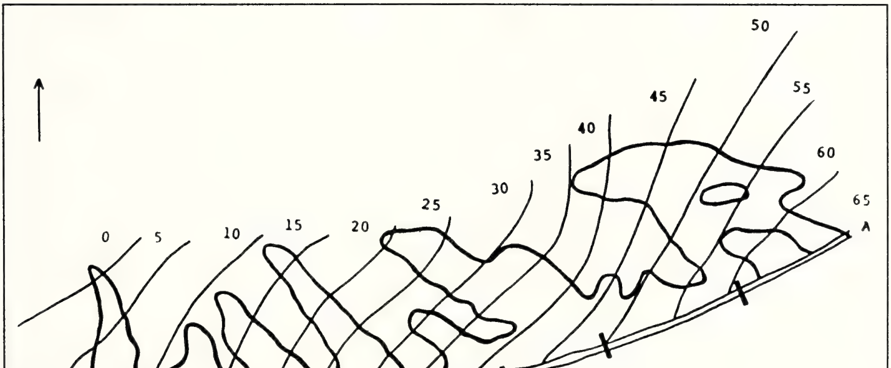

Fig. 1. Diseased site on Five Mile Road. Disease spread by culverts.

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How?

We found that a bulldozer had been brought from infected forests in East Gippsland for use during bushfires in the Verekers in 1962 and that the pathogen had travelled in mud adhering to the tracked wheels. The vehicle was offloaded in a gravel deposit and the disease subsequently appeared both in the tracks made by the dozer and along the roadsides within the national park, wherever the infested gravel was used.

Infection is spread by swimming spores and washed by rain from the gravelled road via culverts and drainage channels into the surrounding vegetation (Fig. 1). This infection spread downhill into a nearby swamp, killing all the Swamp Heath *Sprengelia incarnata* and the regenerating Saw Banksia *Banksia serrata.* These 7 m-high trees in the young stand of *Banksia serrata* were chlorotic (yellowing) in April 1971 and dead by May 1972 (Fig. 2). *Phytophthora cinnamomi* was isolated from the roots. In a patch of 300 trees 60% were dead, and in a nearby area 80% of the trees (140) were killed.

In 1968, infested gravel was used to repair the Tidal River road just north of Darby Saddle (Fig. 3). Later, small patches of dead trees were observed, including dead Hairpin Banksias *Banksia spinulosa* (Fig. 4), and disease spread downhill into the Darby swamp.

Fig. 2. Death of Saw Banksia *Banksia serrata* downhill from Five Mile Rd.

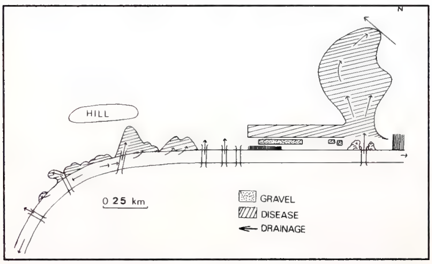

Fig. 3. Tidal River road near Darby Saddle. Infection from roadside gravel.

What are the symptoms of dieback disease caused by *Phytophthora cinnamomi?*

The primary symptom is root decay which is not easily observed. Secondary symptoms may be quite spectacular – the leaves turn yellow, then a rich cinnamon brown, then the plant either dies back gradually, or the whole plant dies suddenly with leaves attached. The shrubs, particularly the Grass trees *Xanthorrhoea australis* die first while the trees usually take 12 months. Symptoms and range of susceptibility were determined for 22 species. Decimation of the susceptible shrubs by *P. cinnamomi* was followed by an increase in resistant sedges, such as the Sword Sedge *Lepidosperma concavum*, the Saw Sedge *Gahnia radula* and the Rope Tassel Rush *Hypolaena fastigiata.*

Measurements

Disease at Wilsons Promontory appeared in a mosaic pattern and extended along the contour at 18 m.p.a. Extension downhill, by zoospores in rainwater was 400 m.p.a. (m per annum) *Phytophthora cinnamomi* was isolated at Wilsons Promontory down to 80 cm below the surface of the deep sands, but most of the pathogen was concentrated between the soil surface and 32 cm down, in the region of maximum root growth. Changes in the vegetation were measured on plots or quadrats. A large number of quadrats were marked see notes shown in Fig. 5. The size of the quadrats varied and was determined from species area curves for each site. Each plant of each species was recorded,

Fig. 4. Dead Hairpin Banksia *Banksia spinulosa* near Darby Saddle.

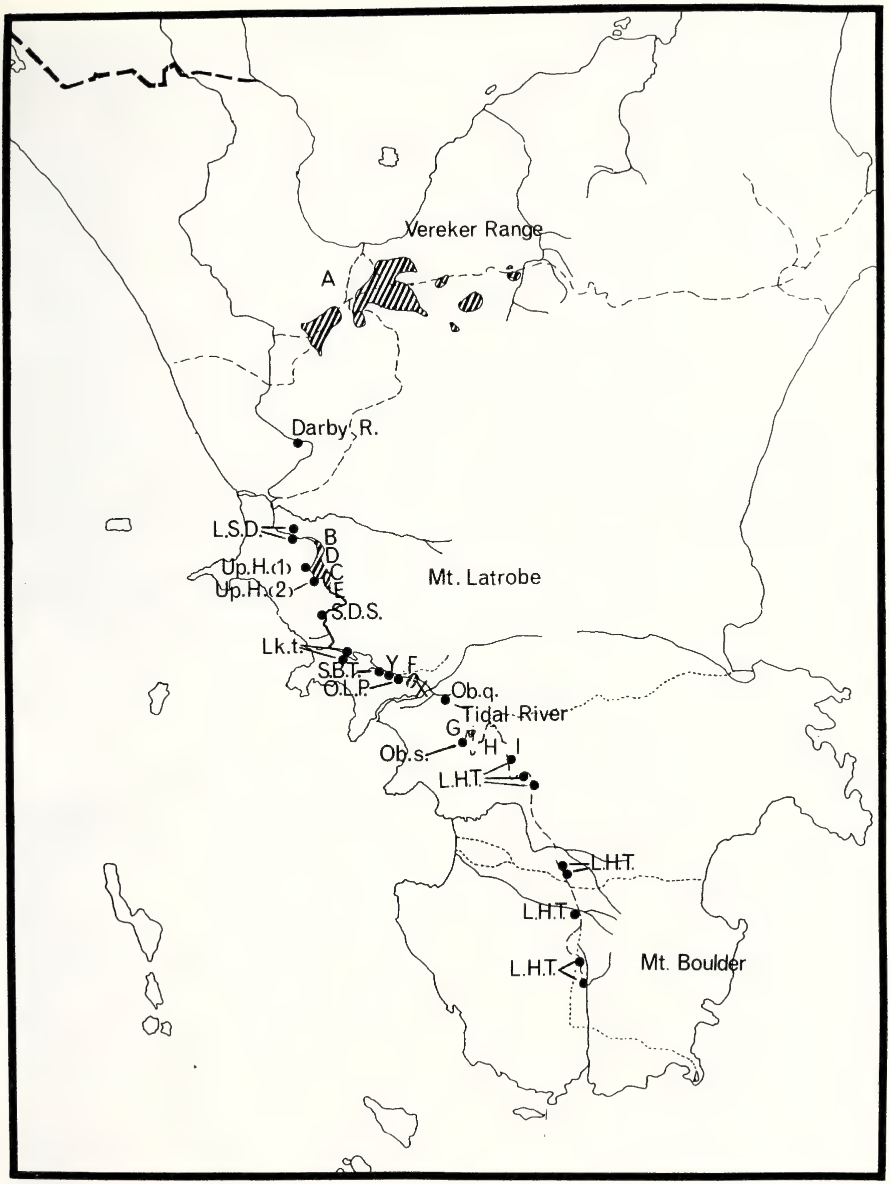

Fig. 5. Map of Wilsons Promontory National Park showing locations of sites. Diseased sites: **A** - Five Mile Road; **B** - road edge; **C** - corner; D - gravel dump; E - old pit; F - Lilly Pilly car park; G - Mt. Oberon summit; H - Mt. Oberon car park; I - lighthouse track; X and Y - Opposite Lilly Pilly car park.

together with any symptoms it showed and the percentage of the area it covered. Changes in these records were noted at each biennial inspection.

Mapping of Disease

During 1972 the distribution of disease and of *P. cinnamomi* were accurately mapped for the whole of the national park (Fig. 5). This map shows only those sites

where the pathogen was found. Every dead or dying tree was systematically tested, and an accurate map was prepared of each disease site with its source of infection (Figs 1, 3). Copies were given to the National Parks Service, which assisted with funds, and to the rangers at the Promontory (Weste 1975). *Phytophthora. cinnamomi* was never isolated from healthy vegetation, although many areas were tested. Experimental inoculation of plants of Messmate *Eucalyptus obliqua* and of *B. serrata* grown from seed proved that the symptoms and deaths observed on the sites were in fact due to *P. cinnamomi.*

Treatment

Early experiments in chemical treatment were made with the assistance of the National Parks Service, the Forests Commission and the Department of Agriculture. Difolatan was sprayed on the Five Mile road site, but it was only temporarily successful. One diseased site which threatened Lilly Pilly Gully was cleared of all vegetation, the roots removed, and, with the help of the Victorian Plant Research Institute, the soil was then sterilised. Unfortunately, 115 mm of rain fell during the process, and, worse still, a pile of gravel on the roadside was not treated, and remained infectious for 5 years. However, as a result of this work, the park used a new pathogen-free source of gravel.

Disease Extension

This most commonly occurs from infected roots by swimming spores which are released into water. Experiments demonstrated that the siliceous sands of Wilsons Promontory stimulated the production of swimming spores. In the spring large numbers of these spores formed on the roots of infected plants and dispersed downhill with rain water (Weste and Vithanage 1979). Other spores, thick-walled resistant spores, were also plentiful in root tissue in dry periods such as autumn. Because of frequent coastal showers, the soil water potential remained uniform and both types of spores were efficient in survival and in spreading infection.

Assessment

All sites were monitored regularly with quadrat analysis, root isolations, changes in plant cover and plant diversity and measurement of disease extension. In 1981 the destruction due to *P. cinnamomi* for the entire national park was assessed (Weste 1981). The dense sclerophyll woodlands and heathlands growing on deep infertile sands had become open sedgelands. Disease had altered both the structure and strata of the plant communities. On infected sites *Phytophthora cinnamomi* had killed two-thirds of the banksia trees and half the eucalypts, and 75% of the shrubs were dead or dying, thus reducing both plant density and plant diversity. Deaths occurred in a mosaic pattern, showing progressive chlorosis and dieback of the branches. The *Hypolaena fastigiata* increased from 5–50% and the *Lepidosperma concavum* from 18.5–73.5% cover, while the percentage of bare ground increased from 0.1–20% on the diseased sites. Also, there was no seedling regeneration, and certain species, such as the Horny Cone Bush *Isopogon ceratophyllus*, *B. spinulosa*, the Common Beard Heath *Leucopogon virgatus* and the Guinea-flower *Hibbertia virgata* completely disappeared from such sites. Disease was most severe on steep ridge sites such as the Darby Saddle (Figs. 3 and 4) where highly significant declines in plant density (both trees and shrubs), diversity and health were recorded. Rare endemic species were at particular risk if susceptible and growing near infection, and the loss of honey and pollen from susceptible species significantly reduced the bird population. Dr. Barbara Wilson's work has demonstrated a significant decline in small mammal populations on diseased sites due to lack of the habitat provided by Grass trees (Wilson *et al.* 1994).

Disease Decline: 1996-1998

Recently, a remarkable recovery has been observed. The grim effects of disease have

Table 1. Decline of Pathogen between 1971 and 1996. % isolation refers to percentage of pathogen from root samples taken from susceptible species. % quadrats infected refers to quadrats on diseased sites that were infected.

Site	% Isolation			% Quadrats infected		
No. samples tested	48-144			3-6		
Year	'71	'81	'96	'71	'81	'96
Vereder Spur	100	100	5	100	100	10
Millers L Rd	100	100	90	100	100	100
Darby Saddle	100	100	27	100	100	75
LP Gully Rd	100	100	96	100	100	100
Light House T	100	100	33	100	100	50

Fig. 6. Regeneration of Saw Banksia *Banksia serrata* and Grass trees *Xanthorrhoea australis* among sedges on Millers Landing Road, 1998.

Fig. 7. Regeneration of Grass trees *Xanthorrhoea australis* among those killed by *P. cinnamomi*, Vereker Spur, March 1998.

changed. In 1996, 26 years after disease from *P. cinnamomi* was first recorded at Wilsons Promontory, we have re-assessed infested sites (Weste 1997). Regeneration of susceptible species has been observed on all diseased sites, leading to a remarkable recovery in the vegetation (Figs 6, 7). The pathogen is still present, but has declined both in population density and in distribution (Table 1). Pathogen populations have declined particularly on the Vereker Range, on the Darby Saddle, and on the Mount Oberon and Lighthouse tracks. In 1996, *P. cinnamomi* was still isolated from samples taken at Lilly Pilly Gully and Millers Landing Road but these are wetter areas that receive drainage and, therefore, support zoospore production.

Regeneration of 20 susceptible species from nine different families has occurred on sites from which they had previously been eliminated by *P. cinnamomi*. Species that have regenerated include most susceptible species, such as the Grass Trees, the heaths and the peas, but there are a few absentees such as the Hairpin Banksia and the Horny Cone Bush, perhaps due to lack of seed on the quadrats. There was a general tendency for the vegetation to return to its pre-disease structure, despite the competition from the resistant flora, such as teatree, sedges and rushes which had replaced the susceptible species for the past 25 years, and despite the occasional isolation of *P. cinnamomi* from the base of some regenerating Grass trees.

All sites were inspected again in March 1998. The regenerating plants, Grass trees and the Banksias, were growing vigorously without chlorosis or dieback. The Horny Cone Bush was regenerating. Even on the lighthouse track sites, regeneration was evident, although it had been absent in 1996 and all signs of disease had vanished from the Mount Oberon sites. However, the number of different species on all diseased sites is not fully restored. Full species diversity and the restoration of balance between the different species will take more time.

The decline in epidemic disease due to *P. cinnamomi* is typical of all epidemics. The reduction of pathogen populations was probably related to the death and hence lack of susceptible host roots, while the survival of susceptible regenerating species was favoured by the recent exceptionally dry seasons, because the swimming spores require free water for production, dispersal and root infection. There may be a resurgence of epidemic disease and another disease cycle should warm moist conditions increase the production of swimming spores and the invasion of new sites. Meanwhile, we hope there is selection for, and survival of, susceptible species with resistance to this pathogen. Disease control would be aided by sprays of phosphonate, which increases plant resistance, and is cheap, water-soluble, and non-toxic to people and animals. It should be sprayed onto the foliage wherever early symptoms appear.

Future Prognosis

At the moment, therefore, the battle is being won. All Field Naturalists welcome the sight of young vigorous Grass trees, of healthy Saw Bankias, of peas and other native plants flowering profusely on formerly diseased sites. In August 1998 fresh symptoms of disease were observed near Lilly Pilly Gully, Tidal Outlook and Waterloo Bay, and the question arises, should we assist the regeneration with the non-pesticide phosphonate, for example near Lilly Pilly Gully if, and when, early symptoms are observed?

Acknowledgements

This work has been assisted by research students and research assistants whose names appear as co-authors of the publications. We have always received excellent co-operation from the rangers at the park and have shared our results with them.

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Fire History: Wilsons Promontory National Park

E.A. Chesterfield[1]

Abstract
Fires, whether unintentional or prescribed, have the capacity to influence species composition on a large scale. European attitudes toward the initiation and suppression of fires greatly influenced the fire regime on Wilsons Promontory. An early period in which hot summer fires were deliberately frequent was followed by fire exclusion. Both periods caused a decline in conservation values. An important aspect of fire policy in a conservation reserve must be its ability to provide fire regimes appropriate to plant and animal communities with a minimum of unnatural disturbance. (*The Victorian Naturalist* **115** (6), 1998, 337-342.

Introduction

The combination of climate and vegetation means much of Victoria is prone to fires. Regeneration may differ in composition depending upon the frequency, intensity and season of burning. Therefore, fires can influence conservation on a large scale. Inappropriate fire regimes may reduce productivity and diversity, making fire management necessary where species are to be conserved. Because a proportion of fires have unpredictable limits and their control is expensive and uncertain, achieving appropriate fire regimes can be a major challenge in the management of natural areas.

Little is known of Aboriginal fire regimes on Wilsons Promontory or elsewhere in Victoria. These developed empirically over millennia and their knowledge may have assisted Europeans toward a common understanding of the role of fire in land management. Instead early fire regimes were determined by graziers. Their dependence on a high frequency of hot summer fires to promote free range grazing often led to damage in localities remote from where the fires were lit. On Wilsons Promontory, large areas of forest which require an extended fire-free maturation period were quickly replaced by vegetation of lower productivity. This experience eventually led to a strong emphasis on protection from fire and a conservative attitude to fire management. On Wilsons Promontory fire exclusion was practised for more than 40 years. The early period when fires were too frequent for forests was followed by an extended fire free period. This has been unsuitable for other vegetation types such as heath and grassy woodland. They have become senescent and replaced by scrubs, lowering diversity over large areas, at least for the foreseeable future.

The sequence of fires has been comparatively well recorded for Wilsons Promontory after its declaration as a national park, and there have been many observations and studies made of their impact on the environment. An appreciation of the fire history gives an indication of how a changing fire regime impacts upon conservation values, and how this has been influenced by changes in fire policy.

Fig. 1. Tall Trees at Vereker Range. Photo courtesy of Historic Places Section, NRE.

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Table 1. Fire History 1900-1960. *CMR Committee of Management Report

Date	Season	Source	Area (Ref [CMR* date])
1863	summer	?	extent unknown (*Gippsland Guardian* 1863).
1907/08	summer	?	entire park (Barrett 1908) or Mt Wilson, Mt Ramsay, Mt Latrobe and Sealers Ck (Ewart 1909).
1912	summer	?	Mt Singapore to Mt Hunter 1912 [4.6.1912].
	summer	?	Leonard Bay, Darby Saddle, Mt Leonard, Darby River headwaters.
1913	autumn	grazing	8000 ha north end down east coast to Mt Ramsay, east and west slopes of the Vereker Range, Mt Vereker. Wet forest and gullies escaped [3.6.1913].
1921	summer	grazing	south-west Corner, Chinaman Ck, Three Mile Beach to south end Five Mile Beach. north-east slopes Vereker Range. Wet forest and gullies escaped [7.6.1921].
1926	summer	?	Biddys Camp, Mt Hunter to Three Mile Beach [13.7.1926].
1926	summer	?	Refuge Cove to Waterloo Bay, Oberon Bay south to lighthouse [13.7.1926].
1927	summer	grazing? camper?	Yanakie Run to Tidal River via Vereker Range, Darby Swamp and Tongue Pt [12.3.1929]. Severe around Pillar Pt, eradicating blue gum stands (Garnet 1970).
1930	autumn	grazing	Cotters Lake to Red Hill [8.7.1930].
1932	summer	linesman	southern end [15.3.1932]. Oberon Bay, Titania Ck, Sealers Cove, lighthouse [18.10.1932].
1933	autumn	boating	Waterloo Bay [18.7.1933].
1937	summer	?	Waterloo Bay, chiefly scrub, little timber burnt *(Argus* 17.1.1937, Webb 1972).
1938	spring	grazing	Yanakie Run and adjacent grazing areas in park [27.2.39].
1939	summer	tourist	started between Darby Saddle and Squeaky Bay, burnt ⅔ of park over a week, including extensive areas of heath south of Mt Hunter, east of airstrip, but not Sealers Cove, Lilly Pilly Gully or Mt Vereker [24.4.39] (*Foster Mirror* 27.7.39, *Age* 13.1.39).
1943	summer	?	Barry Hill-Mt Roundback [7.7.43].
1943	summer	military	hillside below Lookout Rocks, Darby River [7.7.43] Extended into the Verekers and burnt to southern end (Webb 1972).
1951	summer	grazing	90% park excluding Singapore Peninsula, Paradise Valley, Cotters Lake, Tongue Pt west of Sparks Lookout, Fenwick Bight to Mt Oberon across to Squeaky Beach.
1956/57	summer	?	3460 ha, Cow Ck catchment, part of Barry Ck catchment.
1956/57	summer	?	1010 ha, Wet Swamp and southern part of Silver Swamp.
1956/57	summer	prescribed	160 ha north of airstrip.
1957	?	prescribed	140 ha 1 mile east Norman Beach.
	?	?	200 ha Mt Margaret Mt Hunter saddle.
1957	?	?	80 ha East Chinaman Long Beach.

Historic Fire Events

The first wildfire recorded in Wilsons Promontory was observed from a ship rounding the southern end of the park in January 1863 (Table 1). Although the extent is unknown, it was severe, and probably associated with a strong north wind (*Gippsland Guardian* 1863).

Fire may have burnt extensive areas of the park during summer in 1907/08. It destroyed timber at Sealers Cove (Barrett 1908) and Mt Wilson (Ewart 1909) and was sufficiently extensive and intense to threaten '*the pristine grandeur*' of the park. Comment was made of the thick undergrowth that followed (Ewart 1909) and Kershaw (1915) refers to the fallen trees and dense tangled scrub in the burnt areas. Photos of unburnt forest along the Vereker Range indicate that in the early 1900's, the understorey was much more open than today (Fig. 1). Description of forests near Mt Leonard and Mt Latrobe drew attention to their open character and well-developed herb stratum. This was contrasted with similar forest types in other parts of the State (Hardy 1906).

Remnants of cool temperate rainforest are to be found amongst rocky outcrops along the tops of the range between the Verekers and Mt Ramsay. While these reflect an elevated, maritime physiography which promotes cloud formation and fog drip, they also provide an indication of the pre-European fire regime. Many of the rocky outcrops were formerly sheltered

Table 2. Periods of serious rainfall deficiency exceeding 6 months 1872-1960 at SE Point.

Year commencing	Period serious rainfall deficiency (mth)	Interval (mth) to next period
1878	8	67
1884	6	98
1893	6	16
1895	7	18
1897	9	38
1901	13	15
1904	6	29
1907	7	4
1908/09	19	23
1911/12	14	17
1914/15	18	39
1918/19	10	63
1925	7	14
1927/28	13	15
1930	9	15
1932	9	72
1938/39	10	112
1951	?	112

NB. missing records 1951

with Messmate *Eucalyptus obliqua* or covered with Myrtle Beech *Nothofagus cunninghamii* scrubs or forests, according to their exposure. Their size indicates that before the arrival of Europeans, the interval between devastating fires in these higher areas is likely to have been in the order of several centuries (Ashton and Webb 1977).

Between 1907 and 1919 the park experienced extended periods of serious rainfall deficiency (Table 2). A serious rainfall deficiency occurs when the rainfall in a particular month is amongst the lowest ten percent of recorded rainfalls for that month. By definition, once a period of serious rainfall deficiency commences, it continues until above average rainfalls occur (Bureau of Meteorology 1988). Between 1907 and 1919, a serious rainfall deficiency existed over a total of 68 months. This would have contributed to the spread of fires and influenced recovery of vegetation. In 1913 the northern end of the park and the Vereker Range and Mt Vereker were badly burnt, although '*the valuable big timber and fern gullies had escaped*' (Committee of Management Report 3.6.1913). Closely following the fire in 1907/08, this fire may have created areas of unstocked wet sclerophyll forest by burning regeneration incapable of seed production. This area was increased by later fires in close proximity e.g. 1939, 1943 and 1951 (Fig. 2).

There were various management and public reactions to the fires. The fire in 1913 drew a strong anti-grazing protest because burning-off was believed to have been responsible. After fires in 1921, action was taken to burn fire breaks between Tidal River and Oberon Saddle, toward Whisky Creek, and at Biddys Camp, Mt Hunter and the Three Mile Beach. Graziers continued to be implicated as a source of wildfires. After a fire in 1927, the manager of the Yanakie Run was directed not to burn-off between the start of December and the end of February, but with little effect. Extensive areas of Blady Grass *Imperata cylindrica*, believed to exist close to the heathlands at that time, would have made spring burning attractive, and greatly increased the fire risk in montane areas.

Fires and erosion were seen as a major problem. Recollections of 1936 described '*The forests of the west coast were gone and the forests of the east were obviously doomed, owing to the ravages of grazing fires...In loose granitic country landslips and huge slides appeared in many directions...Many streams also brought down vast quantities of silt into the coastal bays*' (Campbell 1952). Fires in 1939 rekindled the controversy over the extent to which burning and grazing threatened or protected the park (*Foster Mirror*, July 27 1939) and attention was drawn to the failure of forests to regenerate and of subsequent erosion. This fire burnt extensive areas of Singapore Peninsular south of Mt Hunter, and from Cotters Lake across onto the lower slopes of the Vereker Range, although it appears to have been more discontinuous at higher elevations.

On the 27th January 1951, a fire commenced in the grazing lands south-west of

Fig. 2. Area at the back of Mt Wilson burnt in 1937. Courtesy Historic Places Section, NRE.

Table 3. Incidence and intervals between fires in the northern heathlands 1908-1951.

General locality	Fire Years	Successive Intervals (yr)
Singapore Nth of Mt Hunter	1908, 1912, 1926, 1957	4, 14, 31
Singapore Sth of Mt Hunter	1908, 1912, 1926, 1939, 1957	4, 14, 13, 18
Mt Roundback	1908, 1913, 1921, 1939, 1943	5, 8, 18, 4
Chinamans Ck	1908, 1912, 1921, 1939, 1943	4, 9, 18, 4
Airstrip east	1908, 1912, 1927, 1939, 1951	4, 15, 12, 12

Corner Inlet (Back Cover E). After burning for some time unchecked it was eventually driven by a westerly gale, travelling from the Vereker Range to the lighthouse overnight, a distance of approximately 30 km (Fig. 3). The fire refocused attention on protection and the Five Mile and Vereker fire breaks were identified as important control lines in the northern area. Further protection was created by construction of the Five Mile Road, completed to St Kilda Junction by 1961 and a system of double fire breaks established from Millers Landing, west of the Vereker Range to Darby River.

Thus between 1900 and 1960, forest fire occurred in 1908, 1913, 1921, 1926, 1927, 1932, 1939, 1943 and 1951, predominantly in summer (Table 1). They were often associated with extended periods of serious rainfall deficiency. Fires in 1913, 1943, 1951 and possibly 1907/08 appear to have been very extensive and severe. Fires repeated with a short interval e.g. 1907/08 and 1913, and 1943 and 1951, would have prevented wet forest regeneration and produced scrub. Other less extensive fires probably involved smaller areas in repeated burning. For example the north-east slopes of the Vereker Range were burnt in 1921, the north-west slopes in 1927, and areas patchily burnt in 1939. During this time the wetter forests and gullies were observed to have escaped the full impact of the fires in 1913, 1921 and 1939, despite the extended dry periods that preceded them (Table 1 and 2). The 1943 fire which started between Darby River and Darby Saddle burnt to the southern end of the park, presumably via the Latrobe Range. This fire also burnt into Lilly Pilly Gully but any damage was not recorded (Webb 1972). Much of this area was again burnt in 1951. The fires of 1921, 1927 and 1939 occurred in different areas of the Vereker Range. Between 1913 and 1951, the varying sequence of fires has produced similar

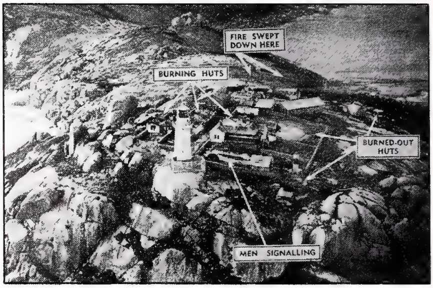

Fig. 3. Fire swept across to the Lighthouse in 1951. Photo held at Historic Places Section, NRE.

fire-free periods of 8–14 years and 24–30 years across the range. For some areas with overlapping fire histories, the frequency would have been greater. Fires were more frequent in other mountainous areas (Table 1). The area south of Mt Ramsay receives the impact of fires driven from the north as the promontory narrows. This area was extensively burnt in 1926, 1932, 1943, and 1951 and possibly also in 1907/08. In the Sealers Creek catchment, large fires were recorded in 1907/08, 1932 and 1951 with drier sites possibly also burnt in 1913. Fires were widespread in Darby River catchment in 1912, 1927, 1943, and 1951 and possibly patchy at higher elevations in 1939.

Heathland also burnt in association with the forest but few fires appear to have been confined to the heath. Heathland fires may burn a comparatively larger proportion of that vegetation, reducing the interval between fires (Table 3). Frequency of fire in northern heathlands appears to have varied from 4–31 years although intervals less than 15 years are more common and only four of the 19 intervals indicate longer unburnt periods, while seven intervals are for periods less than seven years.

Fires appear to have been extensive in heathland south of Darby Saddle in 1912, 1927, 1939 and 1943 (Table 1). This area was largely unburnt in 1951, giving fire frequencies similar to those in the northern heathlands of 4–15 years.

Table 4. Incidence of fires 1960-1990.

Date	Season	Source	Area
1961	spring	deliberate	810 ha Darby River Swamp
1962	autumn	lightning	10110 ha Singapore Block extensively, virtually all Roundback, Chinama and Barry Blocks.
1962	?	accidental	240 ha South Point.
1962/63	summer?	prescribed escape	160 ha Silver Swamp, Northern Vereker Range, Western Little Oberon.
1964	summer	accidental	300 ha Growlers Ck mouth.
1965	?	lightning	200 ha Centre Five Mile Swamp.
1966	?	deliberate	200 ha Several small fires near aerodrome.
1968	?	prescribed	160 ha Millers Landing.
1968	?	deliberate	16 ha East of Cotters Lake.
1971	autumn	lightning	565 ha Chinaman Ck Swamp.
1973	?	prescribed	1730 ha East of Barry Ck.
1976	?	deliberate	250 ha Big Hole.
1976	?	accidental	1800 ha Mt Roundback.
1982	autumn	prescribed escape	38 ha Vereker Range.
1987	?	prescribed	650 ha North of airstrip.
1989	summer	lightning	10 ha Mt Norgate.
1991	spring	prescribed	88 ha Five Mile Rd to airstrip.

Table 5. Incidence and interval between fires in the northern heathland from the last pre 1960 fire until 1992.

General locality	Fire Years	Successive Intervals (yr)
Singapore Nth of Mt Hunter	1957, 1962	5, 30
Singapore Sth of Mt Hunter	1957, 1962	5, 30
Mt Roundback	1943, 1962, 1976	19, 14, 16
Chinamans Ck	1943, 1962, 1971/1973	19, 9/11, 20
Airstrip east	1951, 1987	36, 5

Fire Events 1960-1990

The fire in 1951 proved a turning point for fire management at Wilsons Promontory. The scale of the fire was such that even a casual observer had cause for concern and unauthorized burning-off ceased. After 1951, only small areas of forest have burnt (Tables 4 and 5) although fires have occurred more frequently in the heath (Table 5). Without suppression it is probable that a considerable portion of the heath would have been burnt several times between 1962 and 1976. For many areas there has been a marked change in the earlier fire frequency; for example, large areas of heath around Tidal River and in the catchments of Barry and Chinaman Creeks are now more than 40 years old.

Greater care during periods of dangerous fire weather, the loss of Blady Grass *Imperata cylindrica* on the Yanakie dunes, and an increase in the interval between extended periods of serious rainfall deficiency, have combined to reduce the incidence of fire. Before 1950, fires appear to have been lit regularly with little regard for the preceding conditions and a significant cover of Blady Grass, which is highly flammable and cures early in the growing season, made burning possible over a wide range of conditions.

Between 1908 and 1940, periods exceeding 6 months of serious rainfall deficiency occurred frequently and forest fires were common. However since 1960, the interval between periods of extended serious rainfall deficiency has increased (Table 6) and although fires have occurred during some of these periods, in contrast to the pre-1950 period, other periods have occurred without serious fires.

Conclusion

At Wilsons Promontory excessively frequent hot summer fires were detrimental to conservation in the period up until 1950. Similar experiences occurred elsewhere in Victoria and the public attitude to fire changed. This eventually found expression in the Forests Act 1958 and the National Parks Act 1975 which required that

Table 6. Periods of serious rainfall deficiency exceeding 6 months 1960-1992 at SE Point.

Year	Period serious rainfall deficiency (mth)	Interval (mth) to next period
1960/62	18	63
1967/68	8	92
1976	9	64
1982/83	15	34
1986/88	18	56+

appropriate measures be taken to protect each national park from injury by fire. Injury was seen to be the result of a hot summer fire. In practice, fire was prescribed to reduce hazard and risk in the cooler months and unplanned fires were extinguished in the shortest possible time. However, such fire management did not consider the range of fire regimes necessary to conserve diverse vegetation and animal communities. In many areas where hazard was low, fires did not occur at all. This was typical for much of Wilsons Promontory after 1951 when deliberate burning-off under hazardous conditions ceased. This was no less injurious to heathland communities requiring more frequent fire than the earlier period was to forest which was burnt too frequently. Thus protection of communities from inappropriate fire regimes is much more critical than protection from fire itself. Considering conservation, the maintenance of appropriate fire regimes is the important indicator of an effective fire policy and this may include a proportion of unplanned hot summer fires.

The promontory land form provides an uncommon measure of fire protection. Surrounded by water with the exception of a narrow isthmus adjoining agricultural land, the likelihood of fires spreading into or from the park is low. The comparatively low incidence of naturally occurring fires, is in accordance with the condition of the forests at the time of park proclamation. It contrasts with the period until 1950, when grazing fires were lit under conditions which disregarded other values. Even under these circumstances, the wetter localities on the southern and eastern side of the Vereker Range were often protected. Some of these evidently also escaped under the most severe burning conditions of 1913, 1939 and 1951. Thus although the fire paths of lightning strikes cannot be forecast, it is clear that over a wide range of conditions, infrequent unplanned fire in the mountainous areas of the park need not be regarded as an unacceptable risk to conservation. Unplanned fires will continue to occur. Provided their frequency is not increased by irresponsible acts, such events will assist regeneration in areas deforested by the early European fire regimes (Fig.4.). Because suppression often involves considerable localized environmental damage which is slow or impossible to repair, fire controllers could first consider the effect that an unplanned fire will have on the fire regime. Provided it can occur without causing long term habitat degradation and species loss, such a fire may have beneficial effects, maintaining a range of fire intensities and frequencies in a landscape that has a natural rather than an intensively managed appearance.

Names mentioned in text

Airstrip	Lighthouse	Sealers Cove
Barry Creek	Lilly Pilly Gully	Silver Swamp
Barry Hill	Millers Landing	Singapore
Biddys Camp	Mt Hunter	Penisula
Big Hole	Mt Latrobe	Squeaky Beach
Corner Inlet	Mt Leonard	St Kilda Junction
Cotters Lake	Mt Margaret	Three Mile
Cow Creek	Mt Norgate	Beach
Chinaman Creek	Mt Ramsay	Three Mile
Chinaman Long	Mt Roundback	Creek
Beach	Mt Vereker	Titania Creek
Darby River	Mt Wilson	Tidal River
Darby Saddle	Norman Bay	Tongue Point
Darby Swamp	Oberon Saddle	Waterloo Bay
Five Mile Beach	Oberon Bay	Wet Swamp
Five Mile Road	Paradise Valley	Whisky Creek
Growlers Creek	Pillar Point	Yanakie
Leonard Bay	Red Hill	
Lookout Rocks	Refuge Cove	

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Fauna Survey Group Contribution 20

Post-fire Colonisation of Heathland by Small Vertebrate Species at Wilsons Promontory, Victoria

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Abstract

Both the floristic and faunal composition of heathlands in south-eastern Australia have been shown to be dependent on the frequency and intensity of fire episodes. Four areas of heath with different fire histories were studied at Wilsons Promontory over an extended period of time to determine the temporal and spatial patterns of post-fire colonisation by small terrestrial vertebrates. There were a number of intersite variables in terms of floristic structure, soil composition and aspects at each site. Our results indicate that previous generalisations concerning post-fire colonisation may not necessarily hold true of all habitat types, and that heathlands may show very variable reactions to fire, dependent on these variables. Given the slow rate and variability of colonisation, great caution should be exercised when determining the length of time between ecological burns if vertebrate diversity is to be maintained. (*The Victorian Naturalist* **115** (6), 1998, 343-349).

Introduction

The effect of fire on small mammals and other vertebrate species has been studied at a number of sites in Australia and worldwide. These studies have shown that wildfire has major complex effects on small mammal communities and at the same time they confirm the importance of floristically diverse vegetation communities for small mammal species richness (Wilson *et al.* 1990). It is considered that Australia has developed a fire-adapted flora and fauna and that certain species of heath dwellers prefer heath of a specific age. Based on their responses to fire, small mammals have been divided into three classes: pioneer species or early colonizers (e.g. New Holland Mouse *Pseudomys novaehollandiae*) that reach peak abundance shortly after a fire; mid-successional species (e.g. Brown Antechinus *Antechinus stuartii*, Common Dunnart *Sminthopsis murina*); and late successional species (e.g. Bush Rat *Rattus fuscipes*, Swamp Rat *Rattus lutreolus*) (Newsome *et al.* 1975; Fox and Mackay 1981; Fox 1982).

As elsewhere in Australia, Wilsons Promontory has a long history of Aboriginal inhabitation. Prior to European settlement, fire was probably used as a management tool by the local aborigines to drive game, clear undergrowth and produce new growth in order to attract game species (Recher and Christensen 1981) and, as such, was a component of the ecology of Wilsons Promontory for a long period of time. It has been reported that it can take four or more years for a heathland to build up enough fuel load after a fire to carry another fire (Specht *et al.* 1958). Therefore, it is unlikely that Wilsons Promontory's heaths were burnt at intervals of less than five years and it is likely that a mosaic of different aged heaths existed. The fire control methods used in recent times by park management to protect Wilsons Promontory from wildfire have reduced the frequency of fires and many heath areas have not been burnt for more than twenty years (Offor 1990).

The coastal heath communities, growing predominantly on sandy soils, are important components of the flora of Wilsons Promontory National Park. These heaths contain a high diversity of plants including Dwarf She-oak *Allocasuarina pusilla*, Silver Banksia *Banksia marginata* (Pl. 4A), Sweet Wattle *Acacia suaveolens*, Bush-pea *Pultenea dentata*, Common Flat-pea *Platylobium obtusangulum*, Horny Cone-bush *Isopogon ceratophyllus*, Common Heath *Epacris impressa*, Common Correa *Correa reflexa*, Dusty Miller *Spyridium parvifolium*, Bushy Needlewood *Hakea sericea*, and Prickly Broom-heath *Monotoca scoparia* (Offor *pers. obs.* 1990). The sandy heath communities of Wilsons

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Promontory are reported to be declining in area (Offor 1990). Areas of heathland have been invaded from nearby hillsides by White Kunzea *Kunzea ambigua* and from the coastal sand dunes by Coast Tea-tree *Leptospermum laevigatum*. The dense growth and height of these species effectively excludes other species common to sandy heathland communities, leading to a floristically-simple closed scrub. It is believed that these closed scrub communities support a much-reduced fauna community compared to that of the heath.

The effect of fire regimes on the eradication of White Kunzea and Coast Tea-tree from coastal heathland was investigated in a collaborative research project between the Botany Department of the University of Melbourne and the Department of Natural Resources and Environment (Offor 1990). This was undertaken in an area of severely invaded heathland between Picnic Bay and Squeaky Beach. As part of this study, the Fauna Survey Group conducted post-fire surveys at one of the burnt sections and on a control (unburned) section. Two other heathland sites located further north on Wilsons Promontory with a known fire history were also surveyed. The aim of the surveys was to examine some of the long-term effects of fire on the vertebrate fauna of Wilsons Promontory heaths.

Site Descriptions

Wilsons Promontory National Park is located approximately 240 km southeast of Melbourne and is the most southerly point of the Australian mainland. The mean daily maximum temperatures range from 12°C in July to 21°C in February, with a mean annual rainfall of 1050 mm at the southern tip of the promontory. The climate is described as temperate maritime (Adams *et al.* 1994). Four sites were surveyed and a brief description of each site is given below.

Site 1 (39°1'1"S, 146°17'47"E) (Pl. 4C): an area of approximately 2 ha is located on the south side of Picnic Bay on the central west coast. It is situated on an exposed ridge merging onto a south-west-facing slope with an elevation of 50-60 m. The dominant vegetation prior to slashing and burning was Coast Beard-heath *Leucopogon parviflorus*, Coast Tea-tree, Bushy Needlewood, Dwarf She-oak, Silver Banksia, White Kunzea and Common Correa. The site was slashed in January 1991 and the first fauna survey at this site was conducted in early March 1991. The site was burnt in November 1991 nine months after slashing. Prior to this the site had been unburned for approximately 25 years.

Site 2 (39°1'7"S, 146°18'29"E): located at the western foot of Mount Bishop in the central southwest of the promontory, opposite the Squeaky Beach turnoff. The site is on a slope with a southeasterly aspect and an elevation of 60–80 m. The site was last burned approximately 25 years prior to this survey. The dominant vegetation at the time of commencement of trapping was Coast Beard-heath, Bushy Needlewood, Dwarf She-oak and Hairpin Banksia *Banksia spinulosa* with Coast Tea-tree and stunted Messmate Stringybark *Eucalyptus obliqua*. Site 1 is located approximately 1.5 km west of Site 2.

Site 3 (38°55'59"S, 146°17'38"E): located on the south side of the Vereker Track, 1 km east of the Monkey Creek crossing in the central northwest of the promontory. The site is relatively flat and quite wet in the cooler months of the year, with an elevation of 20 m above sea-level. The site experienced a fire 10 years prior to the survey. The dominant vegetation at the site was Austral Grass-tree *Xanthorrhoea australis*, Silky Tea-tree *Leptospermum myrsinoides*, Dwarf She-oak and Silver Banksia. Patches of Tasmanian Button-grass *Gymnoschoenus sphaerocephalis* and Swamp Paperbark *Melaleuca ericifolia* also occur.

Site 4 (38°57'4"S, 146°19'13"E): this site is located approximately 2 km east of the Wilsons Promontory road on the Miller's Landing Road, 3 km south of Corner Inlet. It is a moderately flat site with some wet, swampy patches at one corner and an elevation of 20 m. Vegetation at the site is Dwarf She-oak, Silver Banksia, Austral Grass-tree, and *Hakea* sp. with some Coast Tea-tree, Scented Paperbark *Melaleuca squarrosa* and sedges in the wetter areas. It was last burned approximately four years prior to the commencement of fauna surveys.

Methodology

The Fauna Survey Group conducted surveys at the four sites beginning in March 1991 at intervals of 3.9 ± 2.5 months. The limitations imposed upon a voluntary group made even spacing of survey efforts difficult at times. The survey at Site 2 was discontinued in February 1994, while surveying at Sites 3 and 4 ceased in March 1994. Surveying at Site 1 is still continuing and was last surveyed for the purposes of this report in October 1997. Site 1 was used to examine the colonisation of regenerating heath by vertebrate species. Site 2 was used as an unburned control as it had structurally similar vegetation to Site 1 prior to slashing and burning and was located in a similar situation to Site 1. Site 2 did, however, have some areas of scattered and stunted Messmate Stringybark *Eucalyptus obliqua* that was absent from Site 1. Sites 3 and 4 were used to examine the effects of heath age on vertebrate diversity and numbers in the central northwest of the promontory.

Techniques employed at all sites were the use of Elliott and cage traps, pitline traps and casual observation. Bait used in the Elliott and cage traps was peanut butter, rolled oats and honey with vanilla essence. The traps were laid out in a grid of four lines of ten, alternating cage and Elliott traps at intervals of approximately 5 m. Each line was spaced at 10 m from the next. A fifth line of ten pitfall traps was installed at the commencement of the study and opened at each survey. The majority of the surveys were carried out for at least two consecutive nights.

Results

Site 1 has experienced major changes due to controlled activities over the last seven-year period. It was completely denuded as a result of the 1991 fire with the bare topsoil being covered by a layer of ash. The pre-fire fauna records for Site 1 were obtained after slashing of the area had been carried out. The habitat was, therefore, severely disturbed at this time

Table 1. Vertebrate species trapped at Sites 1 and 2. Number refers to the number of individuals of each species trapped.
a. 150 trap days/nights prior to burning of the site; b. 1800 trap days/nights after burning of the site; c. 1600 trap days/nights.

Site	Species	Number
Site 1 Pre-fire[a]	**Mammals**	
(post slashing)	Bush Rat *Rattus fuscipes*	1
	Swamp Antechinus *Antechinus minimus*	1
	Reptiles	
	Eastern Three-lined Skink *Bassiana duperreyi*	2
	Amphibians	
	Common Froglet *Crinia signifera*	1
Site 1 Post-fire[b]	**Mammals**	
	White-footed Dunnart *Sminthopsis leucopus*	1
	Swamp Rat *Rattus lutreolus*	2
	Reptiles	
	Southern Grass Skink *Pseudomoia entrecasteauxi*	1
	Eastern Three-lined Skink *B. duperreyi*	2
	Amphibians	
	Common Froglet *C. signifera*	2
	Eastern Banjo Frog *Limnodynastes dumerilii*	3
Site 2[c]	**Mammals**	
(unburned control)	Eastern Pygmy Possum *Cercartetus nanus*	1
	Long-nosed Potoroo *Potorous tridactylus*	1
	White-footed Dunnart *S. leucopus*	3
	Bush Rat *R. fuscipes*	14
	Swamp Rat *R. lutreolus*	21
	Reptiles	
	Metallic Skink *Niveoscincus metallicus*	1
	Yellow-bellied Skink *Nannoscincus maccoyi*	1
	Amphibians	
	Common Froglet *C. signifera*	1

Table 2. Vertebrate species trapped at Sites 3 and 4 between March 1991 and March 1994. Number refers to the number of individuals of each species trapped.

Site	Species	Number
Site 3	**Mammals**	
	Swamp Rat *R. lutreolus*	4
	Swamp Antechinus *A. minimus*	14
	Reptiles	
	Bougainville's Skink *Lerista bougainvillii*	1
	Common Blue-tongue *Tiliqua scincoides*	1
	Metallic Skink *N. metallica*	1
	Eastern Three-lined Skink *B. duperreyi*	2
	White-lipped Snake *Drysdalia coronoides*	2
	White's Skink *Egernia whitii*	6
	Amphibians	
	Red-groined Frog *Paracrinia haswelli*	3
	Southern Toadlet *Pseudophryne semimarmorata*	6
	Common Froglet *C. signifera*	17
Site 4	**Mammals**	
	Southern Brown Bandicoot *Isodon obesulus*	2
	Swamp Antechinus *A. minimus*	5
	Bush Rat *R. fuscipes*	9
	Swamp Rat *R. lutreolus*	23
	Reptiles	
	Metallic Skink *N. metallica*	1
	White-lipped Snake *D. coronoides*	1
	White's Skink *E. whitii*	1
	Eastern Three-lined Skink *B. duperreyi*	3
	Amphibians	
	Red-groined Frog *P. haswelli*	1
	Spotted Marsh Frog *Limnodynastes tasmaniensis*	1
	Southern Toadlet *P. semimarmorata*	6
	Eastern Banjo Frog *L. dumerilii*	15
	Common Froglet *C. signifera*	46

and unfortunately no trapping was undertaken prior to slashing of the site.

The exposed ridge of Site 1 was subjected to severe wind pruning during regrowth by strong, salt-laden south-westerly winds. This process has affected the pattern of vegetation regrowth. Six years after burning the vegetation on the exposed ridge of Site 1 had an average height of 45 cm and approximately 80% ground coverage. The vegetation formed a complex heath community containing Dwarf She-oak, Drooping She-oak *Allocasuarina stricta*, Sweet Wattle, Bush-pea, Silver Banksia, Common Flat-pea, Horny Cone-bush, Common Heath, *E. lanuginosa*, Prickly Guinea-flower *Hibbertia acicularis*, Common Correa, Dusty Miller, Bushy Needlewood, and Tassel Rope-rush *Hypolaena fastigiata*. The dominant vegetation on the steep south-west facing slope of Site 1 was Coast Tea-tree, Prickly Tea-tree *Leptospermum juniperinum*, Dusty Miller, Silver Banksia, Prickly Geebung *Persoonia juniperina*, Prickly Broom-heath *Monotoca scoparia*, Common Aotus *Aotus ericoides*, Spreading Guinea-flower *Hibbertia procumbens* and Angled Lobelia *Lobelia alata*. The vegetation on the slope had an average height of approximately 1 m with 100% ground cover.

In total, eight different species of animals were recorded at Site 1 (Table 1). After the burning of the site, two and a half years elapsed prior to the first vertebrate being trapped (Eastern Three-lined Skink). The first mammal to be trapped at this site was a White-footed Dunnart (Pl. 4D) four years and seven months after fire. Site 1 was surveyed for a period of six years after fire, and over this time period only three individual mammals of two species had been recorded. Swamp Antechinus and Bush Rat (Pl. 4E) were recorded at Site 1 prior to the fire (post-slashing) but have not been recorded since. The amphibian and reptile populations were still low in diversity and numbers of individuals six years after fire. The unburned control site is located approximately 1.5 km east of the

burned site and had a fire-free history of approximately 25 years. Structurally and floristically the vegetation at this site was similar to that of the burnt site prior to slashing and burning. Interestingly, this site supported five terrestrial mammal species, with two species (Bush Rat and Swamp Rat, Pl. 4F) being found in relatively high numbers (Table 1). Compared to other sites at the promontory, the reptilian and amphibian faunas were depauperate, with the Common Froglet being the only frog recorded.

Sites 3 and 4, located on the relatively flat northern half of Wilsons Promontory, were burned 10 and four years prior to the study, respectively. Over a three-year period a total of 13 vertebrate species were recorded at Site 4 and eleven species at Site 3. Both sites supported Bush Rats and Swamp Antechinus but Site 4 had a higher diversity of mammals including the Southern Brown Bandicoot and Bush Rat . Site 4 also carried a higher species diversity and greater populations of amphibians compared with Site 3. Conversely, Site 3 had a slightly higher species diversity of reptiles than Site 4. However, no surveys had been carried out at these sites prior to burning.

The Common Froglet appeared to be the most ecologically tolerant of the amphibians, being recorded from all of the surveyed sites. The Swamp Rat was also recorded from all surveyed sites and the Eastern Three-lined Skink and Metallic Skink were recorded from three of the four sites.

Discussion

In this study of faunal succession after fire in Wilsons Promontory heath, two sites were selected on the western coast of the promontory. Site 1 had a fire-free history of approximately 25 years prior to being burned in November 1991, Site 2 also had a fire-free history of approximately 25 years and acted as the unburned control. A further two sites (Sites 3 and 4) that had fire-free histories of 10 and four years at the start of the study were also surveyed. These sites were located further inland, were less well drained and had different soil composition compared with Sites 1 and 2. Due to these differences in the respective sites, we here treat Sites 1 and 2 separately from Sites 3 and 4.

Australia's fauna has become adapted to the presence of fire in the environment and studies of small mammal diversity and populations after fire have shown a successional pattern. These studies have also shown that fire itself is not the major cause of mortality but the resulting environmental changes, which cause existing populations to disperse or die (Fox *et al.* 1985; Lunney and Barker 1986; Wilson *et al.* 1990).

Whelan (1995) has noted that, in both Australia and America in the period following a fire, many small rodent species show an initial short term increase in population, followed by a decline in numbers. One of the early colonisers after fire in Australia has been shown to be the introduced House Mouse *Mus musculus,* which reaches very high densities within two to four years after fire in coastal heath (Wilson *et al.* 1990; Fox *et al.* 1985). Interestingly, no House Mice were recorded at any of the sites in the current study; however, this species has been recorded on the Yanakie Isthmus just north of Sites 3 and 4 in fairly old heath (FSG, *unpubl. data*). The absence of this species at Site 1 after fire may be due to large tracts of unsuitable habitat surrounding this area. It is more surprising that it was not encountered at Site 4, as this site was only burned four years prior to the study commencing and is relatively close to sites where the species has been trapped. The White-footed Dunnart is an early coloniser of burnt heath and has been recorded in low numbers one year after fire in the coastal heath of Anglesea (southern Australia) (Wilson *et al.* 1990). A single specimen of this species was the first mammal recorded at Site 1, four years and seven months after fire; however, this species was also recorded at Site 2 which had not been burned for 25 years. Lunney (1995) has suggested this species prefers open understorey and low density vegetation in the south-eastern area of the mainland. However, the FSG has also recorded this species in dense old coastal heath near Cape Liptrap (just northwest of Wilsons Promontory). Mid-successional species of southern Australian small mammals include Agile Antechinus (*Antechinus agilis*, formerly *A. stuartii*), Bush Rat and Swamp Rat. The Swamp Rat was first recorded six years after fire at Site 1 when two juvenile males were trapped on one night, indicating that they were probably dispersing. No Bush Rats have yet been recorded. Wilson

et al. (1990), in a study of post-fire recolonisation of heath at Anglesea, found that Bush Rat numbers increased 2–4 years after fire and reached a maximum abundance five years post-fire, whereas Swamp Rat was slower to recolonise, with numbers increasing over 2.5–6 years after fire. The Long-nosed Potoroo is not clearly associated with floristic or structural grouping but favours forest over heath, and utilises a range of differing vegetation densities for shelter and feeding (Bennett 1993). A single, male Long-nosed Potoroo was recorded at Site 2 but this may have been a dispersing juvenile.

From the results of our study it can be seen that the burnt heath of coastal Wilsons Promontory takes a long time to regenerate and that the mammalian fauna associated with heath is slow to colonise burned areas. Six years after fire (at Site 1) only three individuals of two species have been recorded and it is very unlikely that these species are breeding at the site. The small size of the burned site and its situation, surrounded by large areas of closed White Kunzea/Coast Tea Tree scrub may also limit colonisation by some mammals. It is, however, worth noting that the unburned control site harboured a higher mammalian species diversity than Site 1 even after six years of regrowth, and contained such species as White-footed Dunnart, Bush Rat and Swamp Rat that are early/late successional species. The FSG will continue to monitor Site 1 to determine when significant populations of small mammals colonise this area.

Offor (1990) suggested that Site 1 could be burned again after 3-5 years in order to totally remove White Kunzea and Coast Tea Tree. The results of our study indicate that this could be disastrous for small mammalian diversity at these sites and that at least ten years between burns may be needed. Studies have also shown that partial burning of sites may be preferential to the slashing and intense burning that was carried out at this site (Wilson *et al.* 1990). Controlled burning of White Kunzea/Coast Tea Tree scrub and its replacement with a more floristically diverse heath should be undertaken cautiously if relatively high mammalian diversity is to be maintained.

Both Sites 1 and 2 supported a very limited diversity of reptiles (four species) and amphibians (two species). It will be interesting to determine if species diversity increases with the age of the heath. The lower species diversity of frogs at Sites 1 and 2 when compared to Sites 3 and 4 probably reflects the preference of these animals for moist, inland sites as both Sites 1 and 2 were exposed to sea spray.

The two central north-western survey sites (Sites 3 and 4) show that, within Wilsons Promontory National Park heath, responds differently to fire and that management of these heaths has to be site-specific and take into account a number of factors including aspect, soil type, hydrology and so on. In regard to mammalian faunal succession these sites more closely resemble the Anglesea heath studied by Wilson *et al.* (1990). Both of these sites were trapped over a three-year period and both supported populations of Swamp Rat but the capture rate of this animal was five times higher at Site 4. Interestingly, no Bush Rats were trapped at Site 3. Swamp Antechinus, preferring late successional vegetation, is patchily distributed and considered rare in Victoria (Wainer and Wilson 1995). This species was first recorded at Site 4 five years and 3 months after fire. However, it was more commonly found at Site 3 where it was recorded over the entire three-year trapping period. The Southern Brown Bandicoot is considered to be a late coloniser, and was first recorded at Site 4 five years and 2 months after fire, but was not recorded at Site 3 that had been burned ten years prior to the study. The diversity of small mammals in these heaths, therefore, seems to decline 7-10 years after fire. However, the diversity of reptile species was greatest at Site 3. The fact that only one specimen each of Bougainville's Skink and the Common Blue-tongue were recorded at this site may indicate that sampling was insufficient to accurately determine the difference in numbers of reptile species between these sites. Site 4 had the highest diversity and numbers of amphibians of any of the sites sampled. From the results of this survey it would appear that greatest diversity and abundance at inland swampy heaths on Wilsons Promontory occurs within ten years of a fire episode. Further study is needed to determine the vertebrate fauna from zero to four years after fire in this habitat.

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The Second FNCV Wilsons Promontory Christmas Camp 1912-1913

First tree planted at Vereker Range by FNCV members. Photo courtesy Historic Places Section, DNRE.

Mr Pitcher, Professor Ewart and Mr Audas planting seeds on Vereker Ranges.Photo courtesy Historic Places Section, DNRE.

'After tea we found a pleasant surprise awaiting us. Small plots of ground had been prepared on either side of the track in the vicinity of the camp, and it was arranged that each member of the party should plant one of the young trees provided. It was also insisted that each member should stake, label , and water their own particular plant. Mr Pitcher acted as master of the ceremony, and supervised the proceedings. The leader of the excursion was invited to plant the first – a Sunshine Wattle, *Acacia discolor* –immediately opposite the camp. As each planting was completed the chief actor in each case made some appropriate remarks suited to the occasion, which was followed by three hearty cheers. In this way ;thirteen young native trees were planted, and the unique ceremony, which naturally occupied some time, closed with an extra volley of cheers for Professor Ewart and Mr Pitcher ...'

'...Professor Ewart and Mr Audas followed their usual programme of seed planting ...'

Extracts from *The Victorian Naturalist* **29**, 163-170

Mammals Introduced to Wilsons Promontory

John Seebeck[1] and Ian Mansergh[1]

Abstract.
Since the first settlement on Wilsons Promontory, 36 species of mammals have been introduced, either accidentally or deliberately. Three categories of introduction are recognised - invasion by feral exotics, acclimatisation of game species, and attempts to preserve threatened native species. This paper details these introductions and the species concerned. (*The Victorian Naturalist* **115** (6), 1998, 350-356).

Because Wilsons Promontory is, in many respects, an 'island', its mammal fauna reflects some of the biogeographic isolation characteristic of islands. Nevertheless, despite the lack of some species found on the adjacent 'mainland', such as the large gliding possums, its natural mammal fauna was rich and diverse at the time of European settlement, with representatives of most of the families of mammals recorded for Victoria. There are now about 40 species of terrestrial mammal present, comprising some 31 native and eight introduced species. However, a different 'conservation' philosophy, held in the latter part of the 19th and early 20th century, and the accidental spread of some exotic species has resulted in the introduction of a large number of species of mammals to Wilsons Promontory. These introductions may be grouped into three categories; invasion by feral exotics; the acclimatisation of game animals; and the preservation of native fauna - a kind of 'Noah's Ark' syndrome (Jenkins 1977).

Feral exotics

It is probable that the House Mouse *Mus musculus* and Black Rat *Rattus rattus* were the earliest invaders, perhaps coming with the sealers and whalers that operated the first industries on Wilsons Promontory, virtually from the time of its European discovery in 1798 until the collapse of those activities in the 1830s and 40s, or from the timber-getters who began their operations in the late 1840s (Catrice 1998). Both species are still present, but they are uncommon away from human habitation and disturbed areas.

Dingoes *Canis lupus dingo* were part of the natural complement of the fauna of Wilsons Promontory, but were considered to be 'objectionable' and were actively persecuted. Even the Field Naturalists were part of this persecution. Hardy (1906) related that, during the 1905 expedition by FNCV Members, 'authorized by the Minister of Lands, we laid over 100 strychnine baits to lessen the number of this pest...'. Preparation of the Park 'for future use' would commence with 'poisoning of the wild dogs and the erection of a dog, fox and rabbit proof fence across the isthmus'. Kershaw (1906) was also adamant that 'it would seem to be folly to attempt to preserve our indigenous fauna here until something is done to reduce or altogether exterminate this pest from the Promontory.' Kershaw went on to state that the true Dingo was now a rarity, owing to interbreeding with domestic Dogs (*Canis familiaris*). In 1908, no 'true dingoes' were encountered during a visit during September (St John 1909a). By 1912, Dingoes had been 'replaced by the fox' (Kershaw 1913a) and, by the late 1920s, Kershaw was able to state that Dingoes had been completely eradicated (Kershaw 1928). But feral domestic Dogs are still present on the Promontory to this day, and partly fill the niche that was once filled by the Dingo. It is most likely that the earliest settlers had Dogs, and that they were the source of the cross-breeding so distressing to the early naturalists.

The Red Fox *Vulpes vulpes* was successfully introduced to Victoria in the 1870s and, although there are few records of its spread in Gippsland, the species was present on Wilsons Promontory by 1905 (Kershaw 1906) and it was proposed that the isthmus be fenced against foxes, dogs and rabbits (Hardy 1906). Although 'no signs' of foxes were seen in September 1908 (Kershaw 1909), by 1912 the fox was well established (Kershaw 1913b), and was considered 'the only serious pest' and subject to a regular poisoning campaign by 1917 (Kershaw 1917). Red Foxes are still a matter of concern in the National Park

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and are subject to a continuing rigorous control program.

Feral Cats *Felis catus* are also a concern for the conservation of birds and small mammals. In 1971 they were considered to be widespread and common, especially in the Darby River area (National Parks Service files). Dozens were poisoned by the then Lands Department in 1967/68 (B.Coman *pers.comm.*), and control programs continue. The origins of Cats on the Promontory is unknown, but because Cats were kept as pets from the first days of settlement in Victoria (Seebeck *et al.* 1991), it is probable that the species has had a long history on Wilsons Promontory.

Both Cattle *Bos taurus* and Sheep *Ovis aries* were grazed by early pastoralists from the 1860s, and Cattle were agisted in the Yanakie area until the 1980s (Catrice 1998). The Land Conservation Council had recommended that grazing be phased out by 1992. The Committee of Management used Cattle agistment to raise revenue for Park management, and also as track-makers (Ewart 1912). Over 200 Cattle were reported 'enjoying illicit grazing' in the Park in September 1908 and dead Cattle were reckoned to be the source of weed seed (Ewart 1909) - although later Ewart (1912) suggested that Cattle were less injurious as weed-transporters than Horses. Dead Cattle were seen at Growler's Creek in 1910 (Audas 1911). The FNCV resolved to protest strongly against the continuance of grazing in the Park (Barnard and Coghill 1913). Cattle tracks were still present in December 1914 (Kershaw 1915), despite the decision by the Committee of Management that all stock be removed from the Park after June 1913 (Kershaw 1913b). Small numbers of feral Cattle may still be present - the Atlas of Victorian Wildlife has a record from 1993.

Horses *Equus caballus* were also grazed in the Park (Ewart 1909) and no doubt small numbers were effectively feral for a time

Brown Hares *Lepus capensis* were established near Cranbourne in the early 1860s and on Phillip Island by 1865. Their spread to other places began in the 1870s and by the 1890s they were considered a nuisance (Rolls 1984). Brown Hares were present on Wilsons Promontory in 1905 (Kershaw 1906) and 1908 (St John 1909b), but do not seem to have survived. Kershaw (1928) mentioned that they had been present when the National Park was established, and Norris *et al.* (1979) noted that the species had been replaced at the Promontory by Rabbits in the early 1900s. There are no records of Brown Hare in areas adjacent to the Promontory in the Atlas of Victorian Wildlife.

Although Rabbits *Oryctolagus cuniculus* were a major agricultural pest in Victoria by the 1870s, both Hardy (1906) and Kershaw (1906) could report that Rabbits had not yet reached the Promontory (i.e. by late 1905) although both authors strongly advised that steps to prevent the influx need to be taken. During visits in 1908 and 1909, no rabbits were seen (St John 1909b, Ewart 1909). As late as 1917, Kershaw believed that 'there is now little chance of rabbits obtaining a footing on the Promontory' (Kershaw 1917). Sadly, he was wrong. Brian Coman (*pers.comm.*) noted that the Gippsland Rabbit Suppression League was operating by 1898, so Rabbits cannot have been far away from Wilsons Promontory at that time. Of course, Rabbits had been introduced to Rabbit Island about 1836, and caused major change to the vegetation of that island, but were eradicated in 1966-67 (Norman and Harris 1980). Rabbits were also present on Cliffy Island, but have been eradicated from there. These island introductions were of domestic-type rabbits, rather than the wild-type that have become established on Wilsons Promontory (B. Coman *pers.comm.*)

Sportsmen's acclimatisations

A Zoological Society was formed in Melbourne in late 1857, and began to collect a menagerie of native and non-native animals 'for the purposes of science and for that of affording the public the advantage of studying the habits of the animal creation in properly arranged zoological gardens' (de Courcy 1995). For various reasons this venture was not viable and in 1861, when Edward Wilson founded the Victorian Acclimatisation Society, that Society took over the animals belonging to the fledgling Zoological Society and began the task of the 'introduction, acclimatisation and domestication of all innoxious animals, birds, fishes, insects and vegetables whether useful or ornamental…' that was the Society's stated aim (Rolls 1984). This philosophy set the

scene for the next category of mammal introductions to Wilsons Promontory.

Bentley (1978) stated that four species of deer were introduced to Wilsons Promontory during the 1860s. These were Fallow Deer, *Dama dama*; Sambar, *Cervus unicolor,* Chital, *Axis axis* and Hog Deer, *Axis porcinus*. Bentley did not elaborate on the releases of the first two species, and there are no further reports of either species on the Promontory, but Sambar were formerly present on the nearby mainland and on Snake Island in Corner Inlet, where they still persist (Menkhorst 1995d). Wescott (1995) claimed that Sambar were last recorded on Wilsons Promontory in the early 1960s, but we have been unable to confirm that report. Four Chital were released at Waterloo Bay in 1863 (Bentley 1978) and, although Bentley reported that there may have been Chital present as late as 1960, there have been no substantiated reports and it is probable that the species did not persist.

Hog Deer, however, established a thriving population, such that Kershaw (1913a) was able to report that they were common. Bentley (1978) commented upon a culling operation carried out by the National Parks Service and the Fisheries and Game Department in 1953 and 1954, to reduce the estimated 500 Hog Deer in the Park. In 1963, 1080 poison was used to further reduce numbers of deer. In the late 1970s the population was considered to be low (Bentley 1978). Hog Deer can swim well, and in the past there probably has been some exchange or immigration from the mainland or from the islands in Corner Inlet. The Wilsons Promontory population is protected but maintenance of numbers at a low level is part of the Park Management Plan (Parks Victoria 1997).

Preservation of Native Fauna

The reasons for society valuing and wanting to conserve natural areas, and particularly National Parks, have changed over time. So, too, has our understanding of the ways in which conservation should be carried out. The beliefs and endeavours of an earlier generation of conservationists are nowadays sometimes seen as misguided and naive, but their efforts must be viewed in the context of their time. The very fact that Wilsons Promontory had been set aside 'for the preservation of the fauna and flora, for the conservation of the fisheries, and for public recreation' (Gregory 1887) was the catalyst for the introduction of 23 species of native mammals to Wilsons Promontory between 1910 and 1941. Over half of these species would neither have occurred on the Promontory originally, nor in habitat types found on the Promontory, but without the modern understanding that we have about the ecological relationships of native wildlife, the development of Wilsons Promontory as a kind of 'Noah's Ark' was seen as a good way to ensure the survival of species which were already recognised as needing special care. And in any case, it was believed that, at the time of its establishment, 'only about six species of native mammals existed there. These consisted of the common Black-tailed Wallaby, Native Bear or Koala, Echidna, one species of Bandicoot and Ring-tailed Opossum' (Kershaw 1928). This adds up to five only, but Kershaw probably meant to include Common Brushtail Possum. So there was considerable motivation for the introduction of additional species, not only to help their survival but to enhance the value of the National Park.

Many of these introductions did not establish populations and probably died out with the individuals released (e.g. Rufous Bettong *Aepyprymnus rufescens)* whilst other species such as the Tasmanian Pademelon (*Thylogale billardierii*) may have augmented remnant local populations, although the mainland population of that species was probably extinct by that time.

The species which were initially proposed for introduction were kangaroos, wallabies (species other than existed there already), 'smaller marsupials', and Platypus (Hardy 1906). Kangaroos and two species of wallaby were noted as having been 'recently introduced' by Kershaw (1913a), and by 1917 Kershaw estimated the number of introduced native animals and birds to be 192 (three species of kangaroos, four species of wallabies, two species of wombats and three species of 'opossums'. It was hoped that Platypus would be introduced during the ensuing year and 'an endeavour is being made to obtain some Rock Wallabies, which are becoming very scarce' (Kershaw 1917). In 1928, Kershaw was able to report that three species of kangaroos, three species of

wallabies. two species of wombats, three species of possums and two species of bandicoots had been liberated and 'some of these have increased considerably in number' (Kershaw 1928). And in 1941, Kershaw reported that 'since the park was established in 1908, 182 specimens and 21 species of native mammal...have been introduced' (Kershaw 1941).

What were all these species, and what was their fate? From such records as are available, the following annotated list provides some insight into this great preservation experiment. In many instances, the number and origins of the introductions were unrecorded.

Monotremata
Tachyglossidae

Short-beaked Echidna *Tachyglossus aculeatus*. Several were liberated in 1911, although the species had been known from the Promontory since the 1880s (Gregory and Lucas 1886) and is still common.

Marsupialia
Dasyuridae

Spot-tailed Quoll *Dasyurus maculatus*. Three animals were donated by David Fleay of Healesville Sanctuary in February 1941 (Kershaw 1941). Kershaw (1940) quoted a letter from Baron von Mueller noting that he had seen this species at Wilsons Promontory in 1853, but there have been no recent substantiated records. Ecologically, the species would be at home on Wilsons Promontory.

Fat-tailed Dunnart *Sminthopsis crassicaudata*. An unknown number were donated by Charles Brazenor, Mammalogist at the Museum of Victoria in December 1933. Fat-tailed Dunnarts are animals of the grassy plains country, having a broad distribution in the western half of Victoria, and their liberation at Wilsons Promontory was most unlikely to succeed. Its cogener White-footed Dunnart *S. leucopus* is found in coastal and woodland habitats on the Promontory.

Peramelidae

Long-nosed Bandicoot *Perameles nasuta*. Two were received from Mr Quinney of Mortlake (a Museum collector) in January 1911; another four, of unknown origin, were received in May 1923 and liberated south of the Darby Saddle. Long-nosed Bandicoots are present but uncommon on Wilsons Promontory. It is not known if the recent records are a result of these liberations being successful, but ecologically the species could have been present before human intervention. The report by Kershaw (1928) mentions one species of bandicoot being present when the Park was established, but the Southern Brown Bandicoot *Isoodon obesulus* is not uncommon there and it is not possible to determine to which species Kershaw referred.

Eastern Barred Bandicoot *Perameles gunnii*. An unknown number were liberated in 1923. This species is restricted to the grasslands and grassy woodlands of the western Volcanic Plains, where it survives only through an intensive recovery program, and its liberation at Wilsons Promontory was ill-advised.

Vombatidae

Common Wombat *Vombatus ursinus*. One was donated by Mr Crawford in May 1910 and four were donated by Mr Thomson of Kinglake in June 1910. Another, unknown number, which were specifically recorded as having come from King Island, were liberated in May 1910. At that time, wombats from Tasmania and the Bass Strait islands were regarded as separate species, but the King Island wombats became extinct during the 19th century (Hope 1978); perhaps it was Flinders Island from whence they came, since the species still thrives there, despite substantial land clearing. In any case, the fact that animals came from both the mainland and an island was probably the basis for the comment by Kershaw (1928) that two species of wombats had been introduced to Wilsons Promontory. Common Wombats were common when the National Park was established and remain so today.

Phascolarctidae

Koala *Phascolarctos cinereus* (Pl. 4G). Ros Garnet (*in litt.*) commented that 'Dates and numbers not ascertainable, but it is presumed that those introduced were brought in only to relieve the pressure of over-population in other places such as Quail Island'. Koalas were a feature of the Wilsons Promontory fauna. Kershaw (1906) noted that they were very plentiful, and that hundreds had been shot in the past for their skins; Hardy (1906) reported that

2000 had been shot in a year. By 1917, the protection afforded them in the Park had caused such an increase, causing destruction of habitat in some parts of the Promontory that 'it has been found necessary to thin them out'(Kershaw 1917). This 'thinning out' was accomplished by translocation and, in some instances, killing (Kershaw 1934). Koalas are uncommon today.

Phalangeridae

Mountain Brushtail Possum or Bobuck *Trichosurus caninus.* Neither date nor number of animals said to be released is ascertainable. In 1974, the species was reported from Lilly Pilly Gully (Atlas of Victorian Wildlife), but subsequent searches have not confirmed that the species is present, and its inclusion in the modern-day fauna of the Promontory is doubtful.

Common Brushtail Possum *Trichosurus vulpecula*. Two animals were obtained from Mr Quinney of Mortlake in January 1911 and four from Elmore in March 1914. The latter were liberated in Lilly Pilly Gully. An unknown number of animals identified as 'Tasmanian Black Possum *Trichosurus fuliginosus'* were liberated in both September 1913 and August 1914. It has been reported that some of these were kept as pets by the lighthouse keepers. Common Brushtail Possums were 'plentiful' in 1905 (Kershaw 1906) and are relatively common in parts of the Promontory today, although not abundant. Norris *et al.* (1979) reported that the 'larger, darker Tasmanian race ...occurs on Wilsons Promontory ... presumably the result of introductions from Tasmania in the early 1900s', but Menkhorst (*pers.comm.*) did not consider that Common Brushtails seen during surveys in the late 1970s were particularly dark in colour. Some genetic evaluation seems warranted.

Burramyidae

Western Pygmy-possum *Cercartetus concinnus*. An unknown number, of unknown origin, were liberated in March 1934. This species was only recognised in the Victorian fauna in 1970 (Wakefield 1970), and is an animal of the semi-arid north-west of the state. Its congener Eastern Pygmy-possum *C. nanus* is widespread and common on Wilsons Promontory, especially in *Banksia*-dominated woodlands (Ward 1990).

Petauridae

Sugar Glider *Petaurus breviceps*. Four animals, of unknown origin, were liberated in March 1934. Kershaw (1906) predicted that the species would occur on the Promontory, but made no further mention of them. They may have been among the species of 'opossums' released by 1917. Apparently not common today; the most recent record in the Atlas is 1977, of an animal seen at Refuge Cove.

Pseudocheiridae

Common Ringtail Possum *Pseudocheirus peregrinus*. Neither date nor number of animals said to be released is ascertainable. The species was 'plentiful' in 1905 (Kershaw 1906) and remains common and abundant today.

Greater Glider *Petauroides volans*. One animal, of unknown origin, was liberated in the Vereker Range in February 1929 and another, at a site not identified, in March 1934. The species is widespread in the South Gippsland Highlands and foothills to the north of Corner Inlet (Norris *et al.* 1979). Its natural absence reflects the 'island' nature of the Promontory.

Potoroidae

Rufous Bettong *Aepyprymnus rufescens*. Two were liberated south of the Darby Saddle in May 1923. The Rufous Bettong is an animal of the open forests and woodlands of northern New South Wales and eastern Queensland, although it was once found in the Northern Plains of Victoria, close to the Murray River (Seebeck 1995).

Macropodidae

Bennett's Tree-kangaroo *Dendrolagus bennettianus*. Neither date of liberation nor number of animals said to be released is ascertainable. Found only in tropical rainforest on Cape York, its liberation on the Promontory was optimistic, to say the least.

Black-striped Wallaby *Macropus dorsalis*. An unknown number of animals of unknown origin were liberated prior to June 1914. Common in the dense forested habitats it prefers in northern New South Wales and eastern Queensland, it was an unlikely choice for release to the Promontory, and did not become established.

Eastern Grey Kangaroo *Macropus giganteus* (Pl. 4H). A pair were released in 1910 and seven animals from Woodside were liberated two years later, in 1912.

Kangaroos were not, apparently, present on the Promontory when the Park was established, although both Hardy (1906) and Kershaw (1906) enthused about the potential for their introduction. Kangaroos were not encountered in 1908 (St John 1909b). Kershaw (1915) reported 'recent tracks' of kangaroos near Darby river, and just two years later (Kershaw (1917) remarked that they had increased in number. They are now most commonly found in the northern part of Wilsons Promontory and their conservation is part of the Park Management Plan (Parks Victoria 1997).

Common Wallaroo *Macropus robustus*. An unknown number, of unknown provenance, were liberated prior to July 1914. They were identified as *Macropus robustus* var *woodwardii,* now recognised as a full sub-species, which is found in the Kimberley region of Western Australia and in the north-western Northern Territory.

Red-necked Wallaby *Macropus rufogriseus*. An unknown number, of unknown origin, was liberated between April 1911 and July 1914. Ecologically, the Promontory should have suited this species, which is relatively common in both eastern and western Victoria, although the nearest populations to Wilsons Promontory, in the Gippsland Highlands and on the Gippsland Plains are declining (Menkhorst 1995a). The species is present on several Bass Strait islands, and Kershaw noted (1913b) that one of the species of wallaby recently introduced to the Promontory came from Flinders Island. The animals there are a different subspecies to those found on the mainland.

Red Kangaroo *Macropus rufus*. Three animals from Deniliquin were released in May 1914. Although Red Kangaroos are a common zoo and wildlife park species and seem well capable of coping with alien environments, their natural habitat is the arid and semi-arid zones of Australia; in Victoria they are restricted to the far northwest of the State. Their release at Wilsons Promontory was optimistic, and although Kershaw (1917) commented that numbers had increased, they did not establish.

Northern Nailtail Wallaby *Onychogalea unguifera*. Ros Garnet (*in litt.*) noted that two animals, of unknown origin, that were probably this species, were liberated in January 1924. Northern Nailtails are found, not uncommonly, in a broad band extending from the Kimberleys in Western Australia to the Gulf Country in north-western Queensland. Their liberation at Wilsons Promontory seems to have been ill-advised.

Rock-wallaby *Petrogale* spp. An unknown number, of unknown origin, was liberated prior to May 1915. The animals were identified as *Petrogale inornata* (Unadorned Rock-wallaby). Found in the ranges of central coastal Queensland, this seems an unlikely choice, but Kershaw stated in 1917 that 'an endeavour was being made to obtain some Rock Wallabies, which are becoming very scarce'. Certainly, at that time, Victoria's only rock wallaby, the Brush-tailed Rock-wallaby *Petrogale penicillata*, was rare, and the rocky mountainous parts of the promontory must have seemed ideally suited to their establishment. Whichever species was released, it failed to survive.

Tasmanian Pademelon *Thylogale billardierii*. An unknown number were liberated between April 1911 and July 1914. It is possible that they came from Flinders Island, where they are still common and abundant. Kershaw (1913a) noted that one of the species of wallabies recently introduced came from there, but the other species introduced around that period, the Red-necked Wallaby, also inhabits Flinders Island. Norris *et al.* (1983) considered that the Tasmanian Pademelon was extinct in Victoria by the latter years of the 19th century, although Menkhorst (1995b) accepted Lewis' 1931 report of its presence in east Gippsland. Ecologically, the Promontory should have been eminently suited to this species, but it did not become established.

Thus, since the very first days at Wilsons Promontory, some 36 species of mammals have been accidentally or deliberately introduced. Regrettably, several of these, the exotics, have established themselves and are a cause for concern in relation to the conservation of the native fauna. It is probable that the only non-indigenous (to the Prom) species which has established is the Eastern Grey Kangaroo, and so the preservation experiment was virtually a complete failure.

Acknowledgments
Much of the information reported here is derived from an appendix in Menkhorst and

Mansergh (1977), which itself was largely derived from lists supplied by the late J. Ros Garnet. The former National Parks Service permitted access to files on Wilsons Promontory. Surveys by the Fisheries and Wildlife Department in 1977 (Menkhorst 1977), a synthesis of information then available (Norris *et al.* 1979), accounts in *Mammals of Victoria* (Menkhorst 1995c) and more recent distributional information held in the Atlas of Victorian Wildlife database have provided the bases for comments on the modern mammal fauna of Wilsons Promontory. *The Mammals of Australia* (Strahan 1995) was consulted for information about current taxonomy and distribution of non-Victorian species, and Stanger *et al.* (1998) for current usage for non-indigenous species. Peter Menkhorst offered critical comment and helped with our interpretation of some literature records, and Daniel Catrice and Brian Coman were kind enough to share their knowledge about the Park and some of the mammals that are to be found there.

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The Origins of the English Names of Geographic Features on and near Wilsons Promontory

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Abstract
The origins of the names of geographic features on and around Wilsons Promontory are explained, drawing on contemporary accounts of European exploration, naval charts and maps produced since 1798, and modern historical literature. (*The Victorian Naturalist* **115** (6), 1998, 357-372).

Introduction

For thousands of years before Europeans arrived on the Australian coast, the Brautangalang people of the Kurnai group occupied the land known as Wammum or Kurlik, the land now called Wilsons Promontory. For thousands of years before them, their ancestors crossed and recrossed the land bridge that for a time connected Tasmania and the Bass Strait islands to the mainland.

Today, nearly all the names on and around the Promontory are of English derivation, a fact that must distress the spirit of Loo-Errn who safeguards the Promontory. The re-establishment of Aboriginal names on the Promontory seems to me to be the least we Johnny-come-latelies can do to recognise the ancient Aboriginal history in the region.

Even the origins of the relatively recent English names are already becoming hazy as time passes. Voyages of exploration and survey between 1797 and 1887 provided most of the names of coastal features and major peaks: Naval Surgeon George Bass in a whaleboat (1797-98), Lieutenant Matthew Flinders in the schooner *Francis* (1798), Bass and Flinders in the *Norfolk* (1798-99), Lieutenant James Grant in the *Lady Nelson*, an experimental sliding-keel brig (1800-01), Captain John Black in the naval brig *Harbinger* (1800-01), Acting Lieutenant John Murray in the *Lady Nelson* (1801-02), Commander John Lort Stokes in the *Beagle* (1842 - the same *Beagle* that carried Darwin around the world some ten years before), Commander M.G.H.W. Ross in the cutter *Loelia* (1854-55), Lieutenant H.J. Stanley in the brig *Victoria* and lighthouse tender *Pharos* (1868-70) and Commander R.F. Hoskyns in the *Myrmidon* (1886-87). Inland features were named with the opening up of the area to grazing and mining, and with the building of the South East Point lighthouse, the electric telegraph line and vehicle tracks.

Some names have their origins in the desire of early explorers to recognise their friends or persons of political, military or social rank. Others arose simply from the shapes of notable features, from anniversaries of events, or through the names of people associated with the early European exploration or settlement of the region. The origins of some are still unknown.

The locations of most of the features listed here are located on the Outdoor Leisure Map published in 1991 (SMV 1991). The locations of the more distant islands, rocks, capes and inlets can be found on any marine chart of the area.

Here I must acknowledge that the origins of numerous names were long ago set down in the pages of *The Victorian Naturalist* by A.E. Phillips (Phillips 1906); his work was the catalyst for this present paper.

The origins of names

Adam and Eve - This is a close pair of boulders near the point where the old telegraph line swung eastward towards the lighthouse. They are still clearly visible from the walking track, although mostly hidden by tall heath. The origin is obvious, but the author of the name is unknown. It probably dates from the construction of the electric telegraph line in 1873.

Anderson Islets - Named for the first Master of the Ports and Harbours Lighthouse Ship *Lady Loch* (Garnet ms). They are first named on AHO (1938), but probably unrelated to the origin of the name 'Andersons Inlet', which Gardner (1996) says derives from a local squatter.

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Anser Group - 'The Anser group apparently takes its name from the number of geese frequenting the islands; they are three in number, exclusive of three rocks lying about 40 feet high ... Anser Island is the highest, and rises to a nipple point, 498 feet above the level of the sea.' (Victorian Government 1870). The geese referred to are Cape Barren Geese, *Cereopsis novaehollandiae* (family Anserinae), which frequent the islands of Bass Strait and other parts of the southern Australian coast.

Back Drift Track - This track runs up to the 'back' (the southern end) of an enormous sand drift which has been present since at least the 1860s (Stanley 1870).

Bad Saddle - A name once applied to what is now Telegraph Saddle (e.g. DLS 1924), but also locally to the eastern saddle dividing Mt Oberon from Little Oberon: '... we left the telegraph line and turned towards a saddle in the spur last named, locally known as the bad saddle ...' (Gregory and Audas 1885a).

Baie Paterson - The name given by Nicolas Baudin to the bight between Cape Liptrap and Wilsons Promontory, now called Waratah Bay: '... que nous avons appelée Baie Paterson, en l'honneur du respectable savant et voyageur Anglais de ce nom, l'un de plus intimes amis de M. Bass.' (Scott 1911). That is, '... that we have called Paterson Bay, in honour of the respectable English scholar and explorer of that name, one of the closest friends of Mr Bass.' (author's translation). The reference is to William Paterson, who was then Acting Lieutenant-Governor of New South Wales and on friendly terms with the French.

Banyalla Peak - A name coined by Park rangers because of the presence of Banyalla *Pittosporum bicolor* on the peak (J. Whelan, *pers. comm.*).

Bareback Cove - Origin unknown, but possibly a corruption of 'Birbeck's Cove', a place at which Thomas Smith in the *Sally* anchored while sealing in the area in 1824 (Syme 1984 vol.1). Gardner has this, however, as merely an alternative name for Refuge Cove, but cites no authority. Bareback Cove was apparently known by its current name in 1826, when the *Duke of York* called there in search of escaped convicts (Syme 1984 vol 1.).

Barrys Creek, Barrys Hut, Barrys Hill - Presumably after John and Willie Baragwanath, who ran stock on the northern Promontory before the turn of the century. The beach frontage of their later run near Toora was known as Barry's Beach (Garnet 1992). Ewart (1910) mentions Barrys Hill and Barrys Creek as sites at which specimens were collected during a 1908 expedition. Barrys Hut was a ranger's hut built on the shore of Corner Inlet, near the mouth of Barrys Creek (date uncertain). The Forestry Department established a plantation of exotic European trees along the course of the creek in 1909, but, as Garnet (1971) so appropriately put it: 'The few introductions that managed to survive for more than two or three years could not compete with the regenerating native species. They were ultimately overgrown and what the wallabies didn't destroy were despatched by wildfire.'

Bass Strait - Named by Governor John Hunter after George Bass, whose voyage in a whaleboat with six crew in 1797 provided the first firm evidence that Van Diemen's Land was not attached to the mainland, as had been thought (Hunter 1895).

Beehives, The - This was a local name for a group of rocks close to Millers Landing that appeared thus to those arriving by boat (Garnet ms).

Bell Point - A point east of Cape Liptrap, named after Captain William Bell of the *Waratah* (see *Waratah Bay*).

Bennison Island - After Richard Bennison, who in 1850 was granted Yanakie Run, which covered much of the isthmus (Lennon 1974). He had been the licensee of the Port Albert Hotel before moving to Yanakie in 1852, when he was granted two runs, Old Yanakie and Yanakie Head (Crawford 1984). In maps from various periods the island's name is also spelled 'Benison'. The name was apparently given by Commander Ross in 1855 during his survey of Corner Inlet.

Bentley Head - A name given to Townsends Point in Victorian Government (1912), probably from a misreading of 'Bentley Hr' (Bentley Harbour). The proximity of Bentley Point may have contributed to the error.

Bentley Harbour, Bentley Point - The origin of the names is unknown. Bentley Harbour is the name given to the reach of water lying close under the southern shore

of Snake Island, between Bentley and Townsend Points. Bentley Point is at the south-western extremity of Snake Island, thus forming the eastern head of the entrance to Corner Inlet.

Biddy's Cove, Biddy's Camp - According to Wells (1980): 'Some of Millar's station-hands once found a woman convict who had escaped from Tasmania in a small boat with two companions. The woman, Biddy, was living in a small shelter between boulders on Mount Singapore. Millar arranged a pardon for her, and she worked for him as a domestic for many years.' It is possible that 'Biddy' was a nickname given to her, rather than her true name: 'Biddy' was a nickname for an Irish woman, as 'Jock' is for a Scotsman; and 'old biddy' was a common colloquialism for an old or wretched woman. Biddy probably occupied a hut built many years before. Lennon (1974) noted that '... a customs officer and pilot, Charles Petersen, ... was stationed at Biddy's Camp, foot of Mount Singapore from the 1 January, 1859.' Ewart (1910) also mentions Biddy's *Camp*.

Big Hummock - A purely descriptive name for this long, high dune.

Big Snake Island - See *Snake Island.*

Billys Cove - A local name in use in the 1880s for the northernmost cove in Waterloo Bay (Garnet ms).

Bishop, Mount -After Captain Charles Bishop, who had accompanied Furneaux in the *Adventure*, sailed to Port Jackson in 1798 with the missionary trader *Nautilus*, and later turned successfully to sealing in Bass Strait (DPW 1970). In 1801 Bishop returned to Port Jackson as captain of the *Venus*, co-owned by George Bass.

Bishop Peak, Bishop Rock - See *Bishop, Mount.*

Black Rock - See *Buckleys Rock.*

Black Swamp - See *Silver Swamp.*

Blackfish Creek - From the presence of the native Blackfish (*Gadopsis marmoratus*) in the creek. This is the only catchment on the Promontory in which this species has been recorded.

Boat Harbour, Boat Harbour Hill - The name Boat Harbour or Boatharbour Cove was applied for a time to the southern end of Waterloo Bay, now known as Home Cove. 'Boats or yachts caught in an easterly before reaching Refuge Cove will find good shelter in ... Boatharbour Cove under the light' (DPW 1970). This cove was well known to whalers as a safe anchorage for boats (Lennon 1974). The name of the hill that overlooks this haven is the only reminder of the name today.

Bolger Anchorage - Origin unknown. This anchorage in the Glennie Group appears on AHO (1938), and was probably named by Hoskyns in 1886–7.

Bolters Bay - A local name for Leonard Bay, in use in the 1880s (Garnet ms). The origin is unknown.

Boulder Range, Boulder Saddle - The origin is patent. 'The whole mountainous range on Wilsons Promontory is of granite, with immense boulders generally visible, but more particularly on the part known as Boulder Range.' (AHO 1879, Vol. 1).

Stokes' description from 1842 is as appropriate today as it no doubt was then: 'On the southern [side] was a ridge strewn over with immense boulders of granite, one, near where I stood, measuring eighty feet in height, and resting with such apparent insecurity, that little seemed required to send it rolling and crashing into the valley below. . . ' (Stokes 1846, vol. 2).

Brown Head - Named after Robert Brown, the famous naturalist who was the botanist on Flinders' *Investigator* (DPW 1970).

Buckleys Rock (also called ***Black Rock***) - After H. Buckley or P. Buckley, who occupied runs between the modern-day road and Darby River; not after the 'Wild White Man', William Buckley, whose name is associated with places west of Port Phillip Bay. The alternative name Black Rock, by which it was well known to sailors on this coast, probably arose from its colour, caused by encrustations of black lichen, not in honour of Captain John Black.

Bull Flat, Bull Pass - Named for a rogue bull which inhabited these areas in the Vereker Range, the last survivor of the cattle days of the Promontory (J. Whelan, *pers. comm.*).

Bum Rock - 'Bum Rock is a large cleft in the rock face on the eastern side of Dannevig Island ... When you see the huge cleft in the rocks, it is easy to understand how it got its name.' (Niclasen 1995).

Burma Road - A post-WW2 name for the road from Tidal River to Telegraph Saddle, shown on a photograph held in the 'Pictoria' collection of the State Library of Victoria

(Victorian Railways 1947). The name was no doubt a reminder of the association of the Promontory with various Australian and New Zealand Commando units that trained there during World War 2 (Lambert n.d.). A memorial to these units stands in the camping ground at Tidal River.

Cape Liptrap - Named by Lieutenant Grant '... after my friend John Liptrap, Esq. of London' (Grant, 1803).

Carpentaria Rock - The Gulf Line ship *Gulf of Carpentaria* foundered on this previously uncharted rock in the Anser Group on 15 September 1885 on her voyage home to London, and sank within 15 minutes.

Cathedral, The - Presumably from its size and position, towering over the coast between Sealers Cove and Five Mile Beach. The author of the name is unknown.

Chinaman Beach, Chinaman Creek, Chinaman Knob, Chinaman Long Beach, Chinaman Swamp - Chinese fishermen were very active along the eastern coast and in Corner Inlet in the 1860s (Lennon 1974). The name seems to have come about as a result of an unfortunate accident: 'An early fishing disaster occurred when six Chinese were drowned after their small boat was overturned in heavy seas in what is now known as Chinamans Bay.' (Loney 1982).

The 's' has been dropped from these names on most modern maps (e.g. SMV 1991).

Citadel Island - 'Three smaller islands lie off the south point of Glennie Island; the southernmost has been named Citadel Island from its resemblance to an ancient fortress.' (Victorian Government 1870).

Cleft Island - 'One of them was an immense rock; on one side perfectly round, with a large hole in the other, in the form of an arch, with a breastwork rising high enough above the level of the sea to preclude the water from getting into it: the hollow appeared as if scooped out by Art instead of Nature. I gave it the name of the Hole-in-the-Wall. ...' (Grant 1803).

Grant's name apparently did not impress the chart-makers, as the name Cleft Island (sometimes Cleft Rock) appears on subsequent Admiralty Charts. The alternative name of Skull Rock refers to its rather grotesque, skull-like appearance in certain light, reminiscent of the rock of that name in J.M. Barrie's *Peter Pan.* Legend has it that early naval gunners would test their skill by firing round shot into the cave. Cannonballs were supposedly found at the back of the cave by the first people to enter it, but I can find no written record that confirms this story. See also *Dove Rock.*

Cliffy Island - One of the Seal Islands, presumably named for its high cliffs.

Clonmel Island - 'In the month of January 1841, an accident occurred to a passenger steamer named the *Clonmel*, in her voyage from Sydney to Melbourne ... This ship left Sydney on Wednesday, the 30th December, 1840, and on the 2nd January following struck on the beach near Corner Inlet.' McCombie (1858). The *Clonmel* was probably named for the town of that name in County Tipperary, Ireland.

Coffin Rock - 'A spectacular feature you can see from here is Coffin Rock . . . When waves break over this oblong slab, water cascades down the sides to form a white "shroud". ' CFL/VNPA (1987). This is apparently a modern name: I have not seen it on maps published before World War 2.

Coin de Mire - See *Curtis Island.*

Cône, le - See *Rodondo Island.*

Corner Basin - See *Corner Inlet.*

Corner Inlet - Named by Bass in February 1798, because it forms a corner of the coastline between Wilsons Promontory and eastern Victoria (Howitt 1865). However, Bass never explored Corner Inlet as we know it today, and as late as 1970 the name was still applied officially and specifically to the angle of the coast containing the shoals east of Entrance Point (e.g. Stokes 1843), the inlet itself being called Corner Basin: '... the name [Corner Inlet] is generally given to the whole of the funnel-shaped bight ... situated between the north-eastern shore of the promontory and the southern shore of Latrobe or Big Snake Island, leading to Corner Basin, which is an extensive sheet of water, much encumbered with drying sandbanks, lying between Wilson's Promontory and the mainland, to the northwards.' (DPW 1970).

Even so, land maps from the 1860s onward used the name in the modern sense (DLS 1865). An analogy may be drawn with Mallacoota Inlet, a name applied originally to the entrance through the sand bar but later applied to the whole lake system, previously called Pargagoolah Lakes.

Cotters Lake - After W. Cotter, who in the early 1900s occupied a run bordering the southern edge of what was then a freshwater lagoon (DLS 1908).

Cove Creek - A permanent creek running into Refuge Cove, supplying the camping site with fresh water. The origin of the name, which dates back to at least 1868, is obvious.

Cow Creek - Origin unknown, but presumably relating to the cattle-grazing days on the northern Promontory.

Crocodile Rock - Presumably for its resemblance, at close range, to a partly submerged a crocodile: 'This rock ... is a smooth round-topped granite boulder, just protruding above the surface; and in fine weather the sea runs over it without breaking.' (Stokes 1846, vol. 2). The naval brig HMS *Crocodile*, Captain Montagu RN, was used to survey Port Jackson in 1830 (Ingleton 1944), but it clearly post-dates the naming of this rock.

Although Crocodile Rock appeared on the earliest of charts (e.g. Flinders 1803), its exact position was not determined until Stokes's voyage in 1842: 'From a small flattened sugar-loaf, forming the summit of Cape Wellington, I got an angle to the Crocodile Rock, and with others from the south-west end of the Promontory, and from the ship on passing, I determined the position of this danger most satisfactorily.' (Stokes 1846, vol. 2).

Currans Creek - A creek on the northern slopes of Mount Hunter, named after Jack Curran, a shareholder in the Mt Hunter Tin Mine Company. Curran worked at the mine, delivering firewood to the miners' houses (McKellar 1993).

Curtis Island — 'To the eastward there are five islands, the largest of which, from its resemblance to the Lions Mount at the Cape of Good Hope, I called Sir Roger Curtis's Island, who then commanded on that station.' (Grant 1803).

The island was also known rather more imaginatively as The Slipper: 'To the north it slopes away something in the shape of a shoe, from which it is called by sealers "The Slipper". ' (Stokes 1846, vol. 2). This name is given in parentheses on AHO (1863). The French interpreted this shape rather differently, calling the island 'Coin de Mire' (Boullanger 1802), which I take to mean 'The Gunsight'.

Dannevig Island - After Harald Kristian Dannevig, the first Director of Australian Fisheries, who was lost along with all hands when the research vessel *Endeavour* disappeared (presumed sunk in a storm) while returning from Macquarie Island in December 1914. Norwegian-born Dannevig carried out extensive fisheries research in the seas south of Wilsons Promontory, and published several papers on the subject. The name was in use by 1924 and appeared on Admiralty charts for the first time in 1936.

Darby River - This name was in use by 1871 (Dawson 1871a). The most likely origin, I believe, is a Captain Darby, a well-known sea captain who sailed coasts of south-eastern Australia from the 1840s to the 1860s, particularly as master of the *Louisa Campbell.* He sailed the brig *Fairy Rock* to Hobart in 1864, and the ship subsequently sailed in Bass Strait waters (Lawson 1949). The connection of Captain Darby with the *Fairy Rock* and the proximity of Darby River to Fairy Cove may be more than coincidence. Gardner (1996) suggests that it might come from the English surname adopted by one of the last survivors of the Brautangalang Aborigi-nals. Gregory and Audas (1885a,b) and Hardy (1906) mistakenly gave the spelling as 'Derby'.

Deer Flats - From the presence for many years of deer in the area, a population of which still graze on the grassy flats. Axis Deer (*Axis axis*) were first introduced onto the Promontory by the Acclimatization Society in 1863 but have since died out. The Hog Deer (*Cervis porcinus*) that are now established in the park are probably descendants of animals that arrived from Snake Island, where they were introduced in 1865 (VHM 1965).

Deux Pitons, Les - The name (The Two Spikes) given by the French to the two spike-like rocks south of Curtis Island, called by the English, rather strangely, the Sugarloafs.

Devils Tower - An ominous rock tower rising more than 100 metres above the sea north-east of the Curtis Group, named by Flinders (Flinders 1814) and retained by the French as 'Tour de Diable' (Gressien and Lottin 1826). Black (1801) called it 'Devil's Spire'.

Direction Isles - See *Seal Islands*.

Do Boy Island - From its shape, resembling

from some angles a boiled dumpling or dough-boy. The spelling is the original, and not a modern corruption, although 'Doughboy' has appeared on various charts.

Duck Point - Origin uncertain. Probably for the presence of ducks in the vicinity, but perhaps another explanation will come to light.

Dove Rock - A name appended in Anon. (1808) to Cleft Island. The name seems to have been applied only once, then forgotten.

Enclave Point - Origin unknown, but probably simply from the small, enclosed inlet just to the east. An alternative explanation is geological, 'enclave' meaning one type of rock enclosed by another, a common phenomenon in granite.

Entrance Point - This point forms the southern extremity of the entrance to Corner Inlet and the channel to Port Albert (Alberton).

Fairy Cove - Origin unknown, but possibly after the brig *Fairy Rock* (see *Darby River*).

Falls Swamp - After W.M. and T.E. Falls, who occupied runs between Cotters Lake and Darby River in the early 1900s.

Fenwick Bight - Origin uncertain; perhaps after Orlando Fenwick, Lord Mayor of Melbourne in 1871-2, or after the town of Fenwick in Scotland.

Ferny Glade - From the large, cool tree-fern gully through which the walking track passes at this point, in the headwaters of Blackfish Creek.

Ferr Creek - Origin unknown. Possibly a misreading of 'Fern', since this creek is very ferny, like others emptying into Fenwick Bight. An alternative is a contraction of Ferris or Ferrer, a pioneering name in the Yarram-Woodside district (Garnet ms). This creek was once crossed by Second Bridge, long since gone.

First Bridge Creek - The first bridge crossed after leaving the lighthouse is at this creek, apparently so named by the constructors of the telegraph line. The original bridge has long since disappeared.

Five Mile Beach - 'Southward from this projection [Monkey Point] a sandy beach extends five miles, with a rivulet at either end, and separated from a small deep bay [Sealers Cove] open to the east, by a remarkable bluff, [The Cathedral] the abrupt termination of a high woody ridge.' (Stokes 1846, vol. 2). This comment seems to have been converted into a name on subsequent charts.

Forty-foot Rocks - 'Forty-foot Rocks (formerly Ten-foot Rocks) lie S.½E. 4¼ miles from the lighthouse. Captain Kay, R.N., landed on these rocks (a thing not to be attempted once in a year) ...' (Victorian Government 1870).

Frasers Creek - After James Fraser, who occupied the run in the early 1870s (Noonan and Fraser 1969). The name is not on the survey map for the electric telegraph line (Dawson 1871b).

Freshwater Cove - From a freshwater creek that emerges close to the beach in this cove.

George Washington Rock - Although not appearing on any map that I know of, this feature has been known by this name for many years (M. O'Brien and J. Whelan *pers. comm.*). It lies on the eastern side of the main road, not far north of Tidal River. From the northern side the rock looks like any other rock, but from the other side it looks like the head of George Washington in profile.

Glennie Group - (Back Cover D)'... and to the range of islands stretching along the main, Glennie's Islands, after Mr George Glennie, a particular friend of Captain Schanck, to whom I was under personal obligations.' (Grant 1803). Schanck designed the *Lady Nelson*, with its revolutionary sliding keels.

Granite Island - Simply a granite island. Apparently named by Captain Ross in 1855 during his survey of Corner Inlet.

Great Bay - Reported by Gregory and Audas (1885a) as a local name for Oberon Bay.

Growlers Creek - Origin unknown. A nickname would seem to be the most likely origin. An alternative suggested to me by Linden Gillbank is the growling sound of Koalas or possums. The name does not appear on the survey map of the electric telegraph alignment (Dawson 1871b), and thus probably dates from the time when the area was occupied by James Fraser (see *Frasers Creek*).

Gums, The - After the destruction of most of the Promontory's Koala population for pelts shortly before and after the turn of the century, there were grave concerns for the Koala's survival there. In 1934, hundreds of Manna Gums (*Eucalyptus viminalis*) were planted to provide extra food for the Koalas (Noonan and Fraser 1969). This planting site, on the main road, has come to be called The Gums. The Manna Gums, and the Koalas, are still there.

Gum Flat - Origin unknown: perhaps the same origin as The Gums.

Half Way Hut - A hut about half way between Telegraph Saddle and the lighthouse, originally called Martins Hut after the hill on which it stands. It was built in the 1940s by linesmen of the former Postmaster General's department (the PMG) to service the telegraph line.

Hat, The - 'The north end of Sealer's Cove is a high and bold helmet-shaped bluff at the eastern terminal of Latrobe Range, called the Hat.' (DPW 1970). This appears to be a name known only to mariners, but seems appropriate (although the shape is only really apparent from the south).

Hobbs Head, Hobbs Creek - Origin unknown. The name seems to date from Stokes's survey of 1842 and is perhaps after James Hobbs, a noteworthy sailor who, with 12 convicts, circumnavigated Tasmania in a whaleboat in 1824. He was subsequently involved in Bass Strait shipping, and moved to Port Albert in 1854.

Hogan Group - '... an island to the northward [of the Kent Group] which seems to have been one of the small cluster discovered by Mr John Black, and named Hogan's Group.' (Flinders 1814 vol. 1). I do not know who Hogan was.

Hole-in-the-Wall - See *Cleft Island.*

Home Cove - Origin unknown. This cove is a generally safe anchorage for ships, and the name presumably refers to this usage. See also *Boat Harbour*.

Horn Point - 'This projection has two pointed hummocks on it resembling horns.' (Stokes 1846, vol. 2).

Hunter, Mount - Named by George Bass after John Hunter, Governor of the Colony of New South Wales from 1795-1800. 'This double-peaked hill ... was named by Bass after Captain Hunter who succeeded Governor Phillip of New South Wales.' (DPW 1970).

Johnny Souey Cove - Chinese fishermen were very active along the eastern coast of the Promontory in the 1860s, using Sealers Cove and Corner Inlet as their home ports (Loney 1982). It seems likely that this name arose during this time. Gardner (1996) ascribes the name to a Chinaman who lived at the cove, but gives no evidence. The name appears on some maps between 1936 and 1975 as 'Johnny Sussie' or 'Johnny Susie' Cove. Stokes (1843) gives no name to the cove, but has the annotation 'Good watering and Wooding Place'.

Judgement Rock - Named by Matthew Flinders: 'The land to leeward consisted of two small islands and two rocks; the largest of the rocks, from its peculiar form, we called Judgement Rock.' (Rawson 1946).

Kangaroo Valley - An area south of the old airstrip, where Eastern Grey Kangaroos (*Macropus giganteus*) congregate.

Kanowna Island - After the SS *Kanowna*, a 4736 ton steamer which sank after striking the east coast of the island on 18 February 1929 (although DPW 1970, gives the year as 1928). No lives were lost.

Kent Group - Named by Flinders '... in honour of my friend William Kent, then commander of the *Supply*.' (Rawson 1946). Kent was later captain of the *Buffalo.*

Kersops Peak - After Captain M. Kersop (or Kirsopp), who often sailed in Promontory waters as master of the cutter *Midge*. In 1841 he undertook a contract survey of Corner Inlet and the eastern coast of the Promontory with surveyor Robert Russell aboard, and in the same year took part in an exploration of the coast of Gippsland in the *Singapore* (see *Singapore Peninsula*).

Lady (or Ladys) Bay - An early whalers' name for Refuge Cove, so named by Captain H. Wishart after his whaling barque *Lady of the Lake*, of which he was master from 1837 to 1839. Shipping records show that in 1839 Wishart took command of the whaling barque *Wallaby* from a Captain Harburgh, but that he died of heart failure while attempting to rescue the crew of the *Wallaby's* boat at Ladys Bay later in the same year (Syme 1984, vol. 1). Harburgh is subsequently recorded as master of the *Lady of the Lake*, in 1840. Lennon (1974) gave the following account: *The Gipps Land Guardian* (7/3/1856) quotes Dr. J. D. Lang as saying that Captain Wishart, a Tasmanian whaler, named Lady's Bay after his ship, *Lady of the Lake*. George Haydon in his book, *Five Years in Australia Felix*, London, 1846, says that 'Captain Wishurt' belonged to a whaler, the *Wallaby*, and was killed by the blow of a whale's fluke in 1830. A board nailed to a tree in Lady's Bay gave this information and 'four stumps mark the exact spot occupied by the body'. While Haydon (or, perhaps more likely, his printer) got the date

wrong, and the story of death by whale's fluke may or may not be factual, it does seem that Captain Wishart died in his Bay, and that he still lies there. Townrow (1997) gives a good account of recent archaeological survey work at the cove.

La Trobe Island - See *Snake Island.*

La Trobe Range, Mount La Trobe - After Charles Joseph La Trobe, Lieutenant-Governor of the Colony of Victoria from 1851 to 1854.

Lawsons Creek - A creek on the north-east slopes of Mount Hunter, named after Ernest Lawson, who discovered alluvial tin in the creek while prospecting on the Singapore Peninsula in 1904 (McKellar 1993). This discovery led to the opening of the Mount Hunter tin mine a few years later.

Leonard Bay, Leonard Point, Mount Leonard - Origin unknown. Apparently named by Stanley during his surveys in 1868–70. Curiously, Leonard Bay is called 'Sandy Bay' on the map of the alignment for the electric telegraph prepared in 1871 (Dawson 1871b). It would seem from the rough mapping of the coast on Dawson's map that he was not familiar with Stanley's chart of the western Promontory (Stanley 1870) and thus may have been using a local name for the bay.

Lewis Channel - 'Captain Lewis discovered a noble inland lake, capacious enough to ride a fleet of shipping secure from every storm, with a navigable passage from Corner Inlet, and also from Shallow Inlet, the place where the *Clonmel* lies wrecked.' (*The Colonial Gazette*, 9 June 1841: cited by Phillips (1906).

Lilly Pilly - This small hill on the northern Promontory apparently once had Lilly Pillies *Acmena smithii* growing on it. I am not sure if this is still so.

Lilly Pilly Gully - Known from very early days by this name, because of the widespread occurrence of Lilly Pillies *Acmena smithii* in this area. The name was originally applied to the whole catchment between Mt Bishop and Mt Ramsay, including the upper reaches of Tidal River, but is now applied specifically to the creek running south into Tidal River from the La Trobe Range, and more specifically to the area around the boardwalk.

Limestone Track - Presumably named because it led to a quarry from which dune limestone was obtained.

Little Bay - Reported by Gregory and Audas (1885a) as a local name for Little Oberon Bay.

Little Singapore - The name given by mariners to the small peak south-west of Mount Singapore (DPW 1970).

Lookout Rocks - On the track between Sparkes Lookout and Tongue Point, these rocks provide a good vantage point from which to view the western coast and the islands.

Margaret, Mount - Origin uncertain. I have not found the name on maps published before 1936, making Captain John Buyers' brig *Margaret*, in which he explored Bass Strait in 1801, a most unlikely origin. The name might date from the tin mining era, although as recently as 1970 mariners knew it as Wedge Hill (DPW 1970).

Martins Hill - After the lighthouse keeper who was tending the light at the time of the Gregory expedition in 1885: 'The next morning we ... ascended the hill on the other side, known as Martin's Hill, which brought us out on top of a high plateau ... Mr Gregory recognised Mr Martin, the lighthouse keeper, as having seen him at Cape Otway five years before ...' (Gregory and Lucas 1885a).

Martins Hut - See *Half Way Hut.*

McAlister, Mount - Almost certainly after Lachlan McAlister, an early Scottish pioneer in northern and eastern Victoria, who took in the newly arrived Angus McMillan and, in 1839, sent him into Gippsland with stock to find new grazing lands. Alternatively, after one of his many descendants.

McHugh Island - After P.H. McHugh, who assisted Stanley in his survey of Bass Strait from 1868-1870 aboard the *Victoria* and *Pharos* (Stanley 1868).

Middle Yards - Named for the cattle pound yards near this site, shown on DLS (1924) on the eastern side of the road.

Millers Landing - After Alfred Miller, a ranger who occupied a hut at this site in the 1940s after moving from the old hut near the mouth of Barrys Creek (Garnet, ms). After Miller retired, the hut remained unoccupied and was burned to the ground in a bushfire in 1945. Another hut known locally as Millar's Cottage was occupied by William Millar, son of William and Eliza Millar who managed Yanakie Run in the 1870s. The landing and associated buildings were used by travellers arriving by boat from Welshpool before the construction of the

Yanakie Road. A rough track and telephone line connected the landing with the chalet at Darby River. The landing was earlier known as Southwest Corner or South Corner. (See also *Yanakie.*)

Miranda Bay - After the wreck of the *Miranda*, which foundered on rocks to the north of the bay. The rotting timbers of the ship are occasionally uncovered on the beach at Miranda Bay by storms, and debris can still be seen around the headland between Miranda Bay and Five Mile Beach.

Moncoeur Islands - 'An island in with the shore was observed; it bore W.N.W., distant 10 miles. I called it Moncur's island, in compliment to Captain Moncur, of the Royal Navy.' (Grant 1803). There are actually two islands, now called East and West Moncoeur. The spelling 'Moncoeur', which dates from 1844 or earlier, seems to be an accidental corruption in the mistaken belief that the name was derived from French. The error has unfortunately persisted: 'These heart-shaped islands, West and East Moncoeur, aptly named, ... ' (DPW 1970). The author of those words must have had a vivid imagination: the islands are not at all heart-shaped, from any point of view. The French, naturally enough, knew better: Gressien and Lottin (1826) applied the correct spelling.

Monkey Creek - This name appeared on maps for the first time after 1930. 'Monkey' or 'Monkey Bear' was a common name for the Koala, and this seems the most likely explanation for the name of this creek, which is a tributary of Darby River.

Monkey Point - 'The northern-eastern point of the bay [Miranda Bay] , on account of its shape, called Monkey Point.' (DPW 1970). Whether this shape resembles a primate, a Koala, or some other meaning of 'monkey' (including several used by sailors) I cannot say.

Mother Seigel - After a brand of syrup tonic popular after WW1 (Garnet ms). The feature, consisting of a rock 'head' on a rock 'body', was perhaps named facetiously by walkers, and subsequently approved by the Committee of Management. The position was marked incorrectly in Garnet (1971).

Mussolini Rocks - Béchervaise and Burt (1976) provided the only record I have found of this name: 'Long ago, the group [of granite tors] on the ridge between Oberon and Waterloo Bays was called Mussolini Rocks. They may show unrepresentational forms, or still turn their time-sculptured profiles for those who seek the sad, pompous dictator.' There is one rock in this area that bears a striking resemblance to Mussolini with chin raised.

Naturalists' Plain - A name given to the heathy plains south of Millers Landing by A.D. Hardy, after the Field Naturalists Club of Victoria's biological survey which traversed the area in 1905 (Ewart 1909).

Nobbies, The - A group of sand hills so named for their resemblance to the Nobbies on Phillip Island (J. Whelan *pers. comm.*). 'Nobbies' was a common name for any group of high mounds.

Norgate, Mount - After J.W.T. Norgate, who assisted Stanley in his survey of the coast between Cape Liptrap and Wilsons Promontory, 1868–69, aboard the *Victoria* and *Pharos* (Stanley 1868).

Norman Bay, Norman Point, Norman Island (Pl. 2B) - The origin is uncertain. Gardner (1996) states that it was named by George Bass after his commander in the Royal Navy, James Norman. However, the name does not appear on maps until 1870, after Stanley's surveys. A more likely origin is Captain William Norman, a notable mariner who, at the direction of the Victorian Government, sailed HMCS *Victoria* to the Gulf of Carpentaria in search of Burke and Wills in 1861-62. Norman, a surveyor, would have been well known to Stanley, who named other nearby features in 1868 after contemporary surveyors. Dawson (1871b) misnamed Norman Bay 'Little Oberon Bay', perhaps failing to realise that the small bay of that name is nestled at the northern end of Oberon Bay, beneath Little Oberon.

Notch Island - 'Notch Island, the second largest, is 123 feet high, and lies one mile S.E. from Seal Island; it has two hills upon it, and the valley between giving it a notched appearance caused it to be named Notch Island.' (AHO 1897, vol. 1)

Oberon Bay, Oberon Saddle, Mount Oberon, Little Oberon, Little Oberon Bay (Back Cover C) - Named by Stanley during his survey of 1868, not after the medieval King of the Fairies, but after the 100-ton steamer *Oberon*, which was well known in Promontory waters in the 1850s and 1860s (DPW 1970; Syme 1984, vol. 2).

Oberon Saddle was the name given for a

short time to the low saddle between Mount Oberon and Little Oberon, over which the old track to Oberon Bay and beyond passed (DLS 1924).

Old Burn Track - Origin unknown.

Paterson Bay - See *Baie Paterson.*

Picnic Bay, Picnic Creek - Picnic Creek was once a favourite camping spot for walkers on their way to the lighthouse, before the Roaring Meg campsite was established. Picnic Bay was no doubt Picnic Bay was a similarly favourite destination.

Pillar Point - Origin unknown. According to Garnet, tall eucalypts, including Blue Gums *Eucalyptus globulus* once grew on the point, but were burned to ash in the 1927 wildfire (Garnet 1971). This could be the origin of the name, as there is no discernible pillar-like feature on the point nowadays. Another possibility is for a fancied resemblance to treacherous Cape Pillar in Tasmania, the scourge of navigators until the discovery of Bass Strait.

Pyramid Rock - A descriptive name given by Flinders in 1798: '... we came up, at four o'clock, with a small, rocky, ragged, pyramidal-shaped island ... There is a chasm in this pyramid, through which daylight appears when bearing about W-N-W.' (Rawson 1946.).

Rabbit Island - '... the ship lay near a small islet close to the Promontory, about 7 miles from the entrance, which, from the abundance of rabbits, we called Rabbit Island.' (Stokes 1846, vol. 2). The rabbits, according to Stokes, were the descendants of a single pair set turned loose on the island by a person described by Stokes as a 'praiseworthy sealer' a few years before (probably Captain Wishart of the *Wallaby*; see *Lady Bay*). Barrett (1910) reported that their descendants were a breed of small black rabbits which also occupied the islands in Corner Inlet, and which were popular with the local sea-eagles! Stokes himself set down rabbits in the Kent Group, to provide food for anyone unfortunate to be stranded there. It is noteworthy that all these rabbits were released long before 1859, often cited as the date of the first release of rabbits in Australia, by Thomas Austin at Barwon Park, near Geelong.

Rag Island - This is the southernmost of the Seal Islands. The origin of the name is unknown to me, but it might be from the rough rock (= 'rag') on the island. The name appears first on Stokes (1843) and was probably named by him.

Ramsay, Mount - Named by Stanley in 1868 after Robert Ramsay, the tide surveyor at Geelong, who conducted surveys around the Promontory coast (DPW 1970).

Ramsbotham Rocks - Origin unknown. Possibly named by Commander Hoskyns in 1886-87. The name appears on AHO (1938).

Red Swamp - See *Silver Swamp.*

Refuge Cove - Named by Stokes in 1842: 'Refuge Cove, lying 7 miles S.1/2W. from Rabbit Island ... was so named from its being the only place a vessel can find shelter in from the eastward on this side of the Promontory.' (Stokes 1846, vol. 2) See also *Lady Bay.*

Remarkable Stone - Apparently named by Stanley in 1868: 'Half a mile from Southwest Point a fresh water creek discharges itself, and at a short distance inland, and eastward of this, is a remarkable stone near the summit of the coast range, which closely resembles a tower.' (Victorian Government 1870). This stone is shown in a sketch of the view from the highest point on Great Glennie Island, included on Stanley (1868), on the low hill just east of Enclave Point, shown 238 m high on modern maps.

Roaring Meg Creek (Back Cover B) - 'Who named Roaring Meg? A Scotsman, one would imagine, remembering the great Flemish cannon Mons Meg, guardian of Castle Rock.' (Béchervaise and Burt 1976). This suggesation seems not far from the truth. Roaring Meg was a royal cannon used by James II in the siege of Londonderry in 1869. The name no doubt refers to the tremendous roar made by the creek as it passes through a narrow gorge as cascades near its mouth. This gorge was known for a time as Janet Iles Gorge, after the boat of that name in which Arnie Smith brought visitors to that part of the coast (Garnet ms). The name was not used before the 1880s, the first references I can find being in Gregory and Lucas (1885a,b,c), and it was most likely named during the construction of the electric telegraph line.

Rodondo Island - 'There is an island bearing from the western part of the South Cape a little easterly, about twelve miles from the shore. It is round, and inaccessible on all sides. The abovementioned island I called Rodondo, from its resemblance to that rock, well-known to all seamen in the

West Indies.' (Grant 1803). This was not the first name given to the island: Black had already given it the name Round Island (Black 1801), but this name did not stick. The modern spelling is a corruption of Redonda, an island about 20 km north-west of the island of Montserrat which was an important landmark for sailing ships navigating the Caribbean Sea into the port of Saint John's, Antigua. Grant was clearly aware of the pronunciation but not the spelling, since his chart shows the island as 'Redonder or Redondo'. The word 'Island' is an addition by later cartographers, and is a further corruption of the true name. Rodondo is called, appropriately, 'le Cône' on Boullanger's map from the Baudin expedition (Boullanger 1802).

Round Backed Hill - See *Roundback, Mount.*

Roundback, Mount -From its low, rounded shape. Until the 1900s it was called Round Backed Hill. The map in Ewart (1909) indicates the transition, showing both names.

Sandy Bay - See *Leonard Bay.*

Scoop Hole Track - From the presence of a scoop hole ('Well No. 9') along the track. Many of these wells were constructed on the isthmus to provide cattle with water. Most have now been overgrown by vegetation and cannot be found.

Sea Eagle Bay - From a sighting of a White-bellied Sea-eagle (*Haliaaetus leucogaster*) at this place by geologist Gary Wallis, while undertaking research in the area (J. Whelan *pers. comm.*).

Seaforth - McKellar (1993) suggested that this proposed township at the foot of Mount Hunter was named for the town of Seaforth, on the outskirts of Liverpool, England, which in turn may have been named for the loch of that name on the Isle of Lewis in Scotland's Outer Hebrides. Lewis was the seat of Viscount Leverhulme (1851–1925), the founder of the industrial empire which had a factory complex close to Seaforth in England. However, Dr G. Scott suggested to me that a more likely origin would have been Lord and Lady Seaforth of Scotland, who he said were well regarded by the Scots community in Australia at the time.

In July 1889 the area was gazetted as the Township at Mount Singapore, the name Seaforth being applied some time later (McKellar 1993). The plans included 'The Esplanade' along the Corner Inlet frontage and a 'Beach Road' to Three Mile Beach. It is sobering to realise how near the Promontory came to being just another piece of expensive real estate on just another piece of 'developed' coastline.

Seal Island, Seal Islands — George Bass coined these names in 1797 because of the abundance of seals: it was here that Bass and his crew obtained quantities of seal flesh during their whaleboat voyage (see *Sealers Cove*). Because they are aligned roughly in the direction of the entrance to Corner Inlet, these islands have also been known as Direction Isles: 'A group of islets, named from their utility Direction Isles, lies in the fairway, a few miles outside the bar.' (Stokes 1846, vol. 2, p. 427). The modern names of the islands are Cliffy Island, Notch Island, Rag Island, Seal Island and White Rock.

Murray (1802) showed the Seal Islands in the position of the Hogan Group, leaving the true Seal Islands unnamed. This error was quickly corrected by Barrallier (1802).

Sealers Cove - named by Bass on 29/30 January 1798: 'At 5 a.m., the wind setting in from the E.N.E., with a foul and cloudy sky, we hastened to get in our stock of seals' flesh, and then stood over for a little cove under the land. At 10 landed there. This cove, which from the use it may be of to anyone coming here to seal will bear the name Sealers' Cove, is large enough for a small vessel to swing in, and of depth sufficient for any ship to ride in safety. It is shut from all but the winds from E.S.E. to E.N.E., and these, as we had afterwards occasion to see, throw no great swell into it. There is plenty of fresh water, and wood enough at hand to boil down any quantity of blubber they might procure.' (Hunter 1895, vol. 3).

In fact, the cove seems never to have been used by sealers, but rather by whalers and timber-cutters. Whalers would butcher and boil down whales for oil in the cove, and a number of sawmills operated in the cove in the 1840s and 1850s and again in the 1900s (Lennon 1974). Murray (1802) placed Sealers Cove close to Sunday Island, an error subsequently corrected by Barrallier (1802).

Shallow Inlet -The name 'Shallow Inlet' was applied to three different inlets at various times (as well as, at one point, all three at the same time!): the one west of

Yanakie Isthmus that bears the name today, and both the western and eastern entrances to Port Albert (DLS 1865). The words 'shallow inlet' were often used by early navigators, and seem to have been frequently translated into a formal name instead of the original intention of a warning to navigators. The name seems to have been applied to the modern-day Shallow Inlet for the first time by Arrowsmith (1853). This was originally known as Shoal Inlet, but shown on some early maps as 'Shoal Lake'.

Shellback Island - A purely descriptive name, apparently given to the island by Stanley during his later surveys in the area, 1869–70. 'About 1 1/2 miles south-west of Black Rock lies Shellback Island, 357 feet high; it is the northernmost of the islands on the west coast of Wilsons Promontory.' (Victorian Government 1870).

Shelter Cove - A small cove so named because it provides shelter from southerly gales in the lee of Mount Singapore, at the northern tip of the Singapore Peninsula.

Shoal Inlet, Shoal Lake - See *Shallow Inlet.*

Silver Swamp - Named for the colour of the vegetation (Whelan, *pers. comm.*). Red Swamp and Black Swamp were large swamps on the isthmus, outside the park. They are still marked thus on modern maps, although now largely drained and occupied by farms.

Singapore Peninsula, Mount Singapore - Named by members of the Gipps Land Company after the barque *Singapore*, in which they explored the coast of Gippsland as far as Corner Inlet in 1841 to investigate the claims of Strzelecki and McMillan. The members were Messrs Orr, Stewart, Rankin, Kersop, Brodribb, Kinghorn, McLeod and Macfarlane (Heaton 1879). The *Singapore* was not wrecked in the vicinity, as stated in Hardy (1906).

Skull Rock - See *Cleft Island.*

Skull Rocks - A group of weathered rocks on the neck of land connecting South East Point with the mainland. The name presumably derives from their fanciful resemblance to a pile of enormous skulls.

Slipper, The - See *Curtis Island.*

Smith Cove - Origin unknown, but apparently dating from Stokes's survey of 1842 (Stokes 1843). Possibly after George Smith, a seaman on the *Beagle* mentioned in Stokes' account of the voyage (Stokes 1846). Another seaman on the ship, J. Smith, is an unlikely candidate, having been flogged as an example to the other seaman aboard. An alternative origin is J.W. Smith, a seaman well known to Stokes and others who surveyed in Bass Strait. Smith was 2nd mate under Stokes on HMS *Acheron*, then mate and master on survey ships in the Pacific, and later master on the *Loelia* during its surveys of the New South Wales coast (Syme 1984) - the same *Leolia* later used by Ross for his surveys in Bass Strait. Whether J. and J.W. Smith are one and the same I cannot say. Alternative origins are any of the many whalers of the name known to have worked in Bass Strait waters from the 1820s to the 1840s, such as Thomas Smith of the *Sally* (Syme 1984, vol.1).

Snake Island - This island was originally called La Trobe Island, and so appears as such on charts dating from 1843 to the 1970s. The name 'Snake Island' was first applied to an island east of La Trobe Island, which through the shifting of sands eventually came to be connected with the latter. 'The crew and passengers of this vessel [the *Clonmel*, grounded and wrecked nearby in 1841] ... succeeded in reaching in their boats a low woody tract of land, which they at the time imagined formed one of the heads of Corner Inlet ... After some time they discovered they had landed on an island, since called Snake Island.' (Haydon 1846). The name clearly dates from the 1840s, but whether it was named by the *Clonmel* survivors or by others is not clear. The earliest map I have found which uses the name is Arrowsmith (1853). Curiously, the island was still named La Trobe Island on marine charts in the 1930s (AHO 1938), while being called Snake Island on official land maps since at least 1912 (Government of Victoria 1912). This is perhaps because the mariners were aware of the distinction between the two names. The Sailing Directions for 1970 (DPW 1970) gives the alternative 'Big Snake Island', perhaps in recognition of the inevitable change in name.

Sotheron, Mount - This curious alternative name for South Peak, perhaps a combination of 'South' and 'Oberon', appears only once on any map I have seen: the survey map for the electric telegraph line (Dawson 1871b). However, Gregory and

Lucas wrote: 'About mid-day we came out upon the brow of Mount Southern overlooking the lighthouse.' (Gregory and Lucas 1885a). Either they misunderstood the name when it was spoken to them, or the name on the map is an error. The former seems likely, as they record 'the Redonda' and 'Moncure Islands' on the same page, suggesting they did not check the spelling of the features.

Sou' West Corner Track - Simply by virtue of it heading to the south-west corner of Corner Inlet.

Soup Track - Origin unknown.

South East Point - The site of the lighthouse, built in 1859 under government contract by Robert Curram (Crawford 1984). The name arises from the fact that the point lies to the east of the southernmost point on the mainland, South Point.

South Peak - The most southerly of the obvious peaks on the Promontory. The earliest map I have seen with this name applied is Stanley (1870).

South Point - The southernmost point on the Australian mainland (not South East Point, where the lighthouse stands). The name 'South Cape' was applied to the whole of the Promontory by Lieutenant Grant, but the name 'Wilson's Promontory' had already been applied.

Southern, Mount - See *Sotheron, Mount.*

Sparkes Lookout -John (Jack) Sparkes Snr. was Head Ranger at Wilsons Promontory from 1939 to 1956. He saved Tidal River camp from destruction in the 1951 bushfires by carrying out a protective burn some time before, against the wishes of his superiors (Sparkes 1997).

Springs Track - From the freshwater springs that emerge from the coastal dunes on Corner Inlet, near the end of the track.

Squeaky Beach - From the squeaking sound made by the sand under the feet, supposedly caused by the unusual roundness of the grains.

St Kilda Junction - After the famous road junction in Melbourne.

Sugar Basin Swamp - Origin unknown.

Sugarloaf, Little Sugarloaf - Two low rises 1 and 3 km respectively west of St Kilda Junction. The origin is obvious enough, but the author is unknown.

Sugarloafs - The name given to two 100-metre high rocky spikes that rise from the sea just south of Curtis Island. Called by the French Les Deux Pitons (The Two Spikes).

Sunday Island - Named in January 1841 by the occupants of a boat put off from the wreck of the *Clonmel*. 'The adventurers in the cutter proceeded up the bay, and discovered an island covered with scrub, and with poor soil, which they named Sunday Island ... ' (Haydon 1846).

Starvation Flat - Origin unknown, but presumably arising from some long-forgotten incident in the area.

Telegraph Saddle - This is the saddle over which the electric telegraph line passed on its way to the lighthouse. It was known for many years as 'Bad Saddle' (e.g. DLS 1924, 1930).

Telegraph Swamp - After the electric telegraph line, which skirted the western edge of this swamp.

Tidal River - A simple descriptive name, from the tidal nature of the estuary, greatly influenced by tides. At times it can be reduced to small pools and at others can be a deep, fast-flowing stream. The author of the name is not known, but the earliest reference to the name is on the survey map for the electric telegraph line (Dawson 1871b).

Tin Mine Cove - The site of a boat landing that serviced the tin mine on the slopes of Mount Hunter, which operated from 1920 to 1936 (McKellar 1993).

Tin Pot Track - Origin unknown.

Titania Creek - Presumably after Titania, Queen of the Fairies, because of the creek's proximity to Mount Oberon.

Tongue Point - A name that seems to have been coined by Stanley (Stanley 1868), obviously because it forms a tongue-like projection of the coastline. 'Tongue Point is 167 feet high, and lies S.½E. 2½ miles from Black Rock, the coast between forming a deep bight ... Tongue Point has a remarkable conical white rock, 30 feet high, close off it to seaward.' (Victorian Government 1870).

Townsend Point - Thomas S. Townsend, a government surveyor, surveyed the coast of Corner Inlet in 1841 in the government schooner *Isabella* (Syme 1984, vol.1) and prepared a fine map with much detail of the Promontory side of the inlet (Townsend 1841). Two points now bear his name. One is the southern point of Snake Island. This point is still called Townsend Point, but has appeared on maps as 'Bentley Head', apparently an error (See *Bentley Head*). The second is the small

point on the eastern side of Yanakie Isthmus, immediately south of Duck Point.

Two Mile Point - A name apparently given during the 1940s to modern-day Lighthouse Point, probably mimicking the established names Five Mile Point and Three Mile Point (Victorian Railways n.d.).

Varneys Waterhole - A miner named Varney was employed by the Yanakie quartz Mining Company to prospect for gold on the northern boundary of Yanakie Run (Noonan and Fraser 1969). How his name might have come to be associated with this scoop hole is not known.

Vereker Range, Mount Vereker, Vereker Outlook - Named by Stanley (Stanley 1868). According to the *Sailing Directions (*DPW 1970), this was the name of an early surveyor in the area, probably Foley C.P. Vereker, who may have been known to Stanley. Vereker later explored Cambridge Gulf in Western Australia in 1888 as commander of the *Myrmidon.*'Mount Vereker, the north-west mountain of the Promontory, bears N.E. by E. distant 6 miles from Tongue Point.' (Victorian Government 1870).

Waratah Bay - After the *Waratah*, which anchored in the Bay in 1854 to effect repairs to a damaged rudder. 'In 1854 I belonged to the S.S. *Waratah*, Captain William Bell ... After passing Gabo in a heavy storm her rudder got out of order, and Captain Bell took the ship into a then unknown bay, where we anchored until the storm abated. On taking up anchor, the clay attached to it showed good holding ground, and Captain Bell forwarded it to the Customs on arrival in Melbourne. The bay was then named and is now called 'Waratah Bay' (Lamond 1911). The bay was, in fact, already well known by the time of the visit by the *Waratah*. It had been called Baie Paterson (Paterson Bay) by Baudin in 1802, but the name was not taken up by the English (Wells 1980) - reasonable enough, given the state of affairs between the two countries at the time. Grant (1803) called this stretch of water between Cape Liptrap and Wilsons Promontory 'King George's Sound' after King George III, a name which seems never to have caught on.

Waterloo Bay - 'Cape Wellington, the eastern projection of Wilsons Promontory, forms the north point of Waterloo Bay, which is wide and spacious. These names were suggested by the fact that the day of our anchoring there was the anniversary of one of the greatest triumphs ever achieved by British arms.' (Stokes 1846, vol. 2). Stokes' reference to British *arms* rather than British *soldiers* perhaps reflects his knowledge that some two-thirds of Wellington's army at the Battle of Waterloo on 18 June 1815 consisted of Germans, Dutchmen and Belgians, and it was supported in the later stages of the battle by Blucher's Prussian Army!

Wattle Island - Probably named by Stanley in 1868-69, perhaps after Coast Wattle *Acacia sophorae* that may have been flowering. The name appears for the first time on Stanley (1870).

Wedge Hill - The old mariners' name for Mount Margaret: 'Between Mounts Roundback and Hunter the range falls considerably, and about midway is Wedge Hill, 715 feet ... high.' (DPW 1970).

Wellington, Cape - See *Waterloo Bay*.

Whale Rock - There are two Whale Rocks on the Promontory. The best known is the rock on the northern bank of Tidal River downstream from the new footbridge, resembling a head-on view of a Sperm Whale. The other, presumably also named for its resemblance to a breaching whale, lies off Three Mile Beach: 'The rock ... dries to 3 feet, and is a danger to small craft coasting at high water.' (DPW 1970). SMV (1991) mistakenly applies the name to the rocks on Lighthouse Point.

Whisky Bay - Folklore has it that this namearises from cases of Scotch whisky washed onto the beach many years ago, perhaps carried overboard during a storm (J. Whelan *pers. comm.*).

White Rock - The northernmost of the Seal Islands, named simply for its white colour.

Wilson, Mount - Originally thought to be the highest peak on the Promontory, and presumably also named after Thomas Wilson for whom the Promontory was named. 'On the northern side of it [Boulder Saddle], the highest hill, Mount Wilson, rises abruptly until its woody crest reaches an elevation of 2350 feet.' (Stokes 1846, vol. 2).

Wilsons Promontory - Named Wilson Promontory (the 's' being added later) by Governor Hunter, at the suggestion of George Bass and Matthew Flinders, after Thomas Wilson, a London merchant and friend of Flinders (Hunter 1895). DPW

(1970) states that Wilson was also the surgeon-tutor of Bass.

Windy Saddle - The high saddle between the catchments of Titania Creek and Blackfish Creek, over which the track to Sealers Cove passes. The saddle is exposed to the full force of winds from the south, south-west and east. It was once known as Ramsay Saddle (Garnet 1971).

Yanakie - The name of the run taken up by Richard Bennison in 1850, supposedly named from the Aboriginal word *yanaka*. Garnet (ms) states that the late Mrs Susan Greenaway of Hedley recalled that Mrs Bennison interpreted the name to mean 'up and come back', referring to the difficulty in crossing the high dunes (i.e. one step forward and two steps back). Yanakie homestead, a small timber house, was built in 1866, close to the present-day entrance to the Park. By the 1950s it had become derelict, and was demolished in 1957 (Crawford 1984).

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A. Long/Tall Club Moss *Huperzia varia*. Photo by J. Eichler.

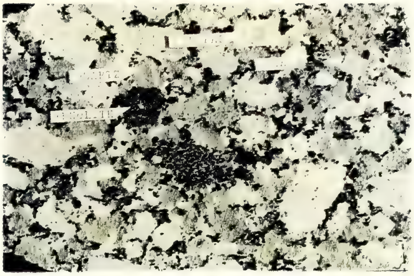
B. Oval Wedge-fern *Lindsaea trichamanoides*. Photo by J. Eichler.

C. Promontory Daisy-bush *Olearia allenderae* near Five Mile Gate, 1998. Photo by D. Meagher.

D. Crimson Berry *Cyathodes juniperina* Vereker Range, 1995. Photo by J. Eichler.

PLATE 3

A. Silver Banksia *Banksia marginata*, 1969. Photo courtesy Historic Places Section, NRE.



B. Enclave granite crystals. Photo by Gary Wallis.

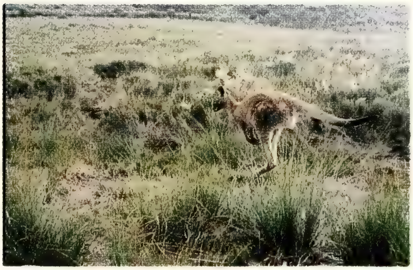
C. Picnic Bay (Site 1 in the study by Thompson *et al*, p 335), 1994. Photo by R. Gibson.

D. White-footed *Dunnart Sminthopsis* leucopus. Photo by R. Forse.

E. Bush Rat *Rattus fuscipes*, 1980. Photo by M.L. Turner.

F. Swamp Rat *Rattus lutreolus*. Photo by T. Sault.

G. Koala *Phascolarctus cinereus* on Lighthouse Track, 1980. Photo by D. Meagher.



H. Eastern Grey Kangaroo *Macropus giganteus* near St Kilda Junction, 1995. Photo by D. Meagher.

PLATE 4

A. North-west coast from Mount Oberon. Photo by G. Wallis.

B. Roaring Meg, Fenwick Bight, 1969. Photo courtesy Historic Places Section, NRE.

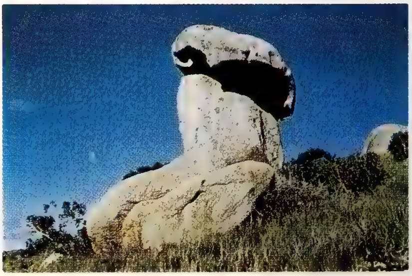
C. Oberon Bay and Norman Bay, 1977. Photo by G. Wallis.

D. Glennie Island. Photo by G. Wallis.

E. Regenerating Eucalypts, November 1953) after the 1951 fire. Photo courtesy Historic Places Section, NRE. Luly Collection.

F. White Mangroves *Avicennia marina* Corner Inlet, 1996. (Little Drift in Background). Photo by D. Meagher.

G. North-east. Great Glennie Weathering, 1975. Photo by G. Wallis.



H. Granite Tor, Vereker Range, 1960. Photo courtesy Historic Places Section, NRE.

Wilsons Promontory

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The Victorian Naturalist would not be successful without the enormous amount of time and effort voluntarily given by a large number of people who work behind the scenes.

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Cover: Peter Menkhorst receiving the 1998 Australian Natural History Medallion (see article p. 4). Photo by Wendy Clark, Empathy Photographics.

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Australian Natural History Medallion 1998

Peter Menkhorst

'Destruction of habitat' is a phrase heard frequently these days, and it is the reality behind this that makes the work of this year's Medallionist so important and valuable. For more than twenty-five years, Peter Menkhorst has been involved with endangered species of birds and mammals, either by field survey, research or coordinating recovery efforts. As a Wildlife Scientist in the former Fisheries and Wildlife Department, and since 1996 a Senior Wildlife Policy Officer with the Department of Natural Resources and Environment, he has played a major role in improving knowledge of Victoria's wildlife and developing recovery strategies.

The Orange-bellied Parrot Recovery Project, one of the first intensive recovery efforts undertaken in Australia, required the collaboration of the wildlife agencies of the Victorian, Tasmanian, South Australian and Federal Governments, Birds Australia, and other non-government agencies. Peter Menkhorst has been the Victorian representative on this recovery team since its inception in 1983. He developed and led the Helmeted Honeyeater Recovery Effort, involving the coordination of scientists from a variety of disciplines, and in 1993 he was put in charge of the recovery of the Regent Honeyeater, an ecologically complex project, also requiring the coordination of organisations in three States. He has collaborated in the preparation of recovery plans and Action Statements under the Flora and Fauna Guarantee Act for the Orange-bellied Parrot, Helmeted Honeyeater, Regent Honeyeater, New Holland Mouse, Squirrel Glider and the Koala in New South Wales.

Peter has been involved in many field surveys, often as team leader. These included investigation of the requirements of the Squirrel Glider in northern and central Victoria, the Smokey Mouse in the Eastern Highlands, and the feeding ecology of Australasian Gannets breeding in Port Phillip Bay, Victoria.

The status of the Koala is a vexed question. Overpopulation is a problem in parts of Victoria, and since 1995 Peter has coordinated Koala management across the State, including investigation of options for fertility control. He represents Victoria on the National Koala Network, which has prepared a National Strategy for Koala Conservation.

In 1995 Peter represented Australian wildlife agencies at a workshop on Population and Habitat Viability Assessment for the Komodo Dragon, in Bogor, Java, and later encouraged and facilitated the Conservation Breeding Specialist Group of IUCN to conduct the first such workshop in Australia, for the Spotted Tree Frog.

The *Atlas of Victorian Mammals* project was set up under Peter's leadership in 1980, and he was responsible for the formation of a detailed computer database for mammal records for Victoria. This now includes records of all Victorian vertebrates and is the most comprehensive of its kind in Australia. It formed the basis for *Mammals of Victoria: distribution, ecology and conservation* (1995), for which Peter was the major contributor and editor. In 1996 it received a Whitley Book Award from the Royal Zoological Society of New South Wales. Other publications include contributions to books on the ecology of the Mallee, the status of Australia's seabirds, possums and gliders, *Fauna of Australia, Volume 2 - Aves* and the *Handbook of Australian, New Zealand and Antarctic Birds*, and over 100 articles to journals both scientific and popular.

Over 130 of Peter's photographs have been accepted for the Australian Museum's *National Photographic Index of Australian Wildlife*. Some have been used in the series of books published by the *Index*; others in *Mammals of Victoria*, and in R. Strahan's *Complete Book of Australian Mammals*.

Programs for the recovery and management of endangered wildlife rely very

heavily on research, and Peter has designed and co-supervised projects at PhD and BSc Honours level on aspects of the ecology of the Orange-bellied Parrot and the Helmeted Honeyeater. Input from amateur groups is also of great value, and Peter has been very active in cooperating with them to achieve common goals.

Peter is a member of Birds Australia, the Bird Observers Club of Australia, the Australian Mammal Society, the Australian Bird Study Association, the Victorian Ornithological Research Group (V.O.R.G.), who nominated him for the Australian Natural History Medallion, as well as various 'Friends' organisations. He was a committee member of V.O.R.G. for twenty years, and a member of the Healesville Sanctuary Advisory Committee between 1991 and 1995. He has presented over 50 talks to naturalist clubs, and has done much to raise public awareness of the plight of endangered species, and to involve the wider community in the protection and preservation of their habitat.

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Errata

In Volume 115 (5), Mount Buffalo Centenary Issue, the captions on pictures A and B on Plate 5 were reversed. They should read: **A**. *Oreixenica latialis theddora*, a subspecies of the Browns endemic to Mount Buffalo. Photo by David Crosby; **B**. Common Silver Xenica *Oreixenica lathoniella herceus* which flies at the same time as *O. latialis*. Photo by David Crosby. These photographs accompany the paper by David Crosby entitled 'The Butterflies of Mount Buffalo National Park', pages 222-225.

The editor apologises for any misunderstanding this has caused.

Special Issues

The Victorian Naturalist

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Wilsons Promontory Centenary Issue Volume **115** (6) 1998

Copies are available for purchase from Parks Victoria offices at the Mount Buffalo and Wilsons Promontory National Parks or the FNCV Office, Locked Bag 3, Blackburn 3130, Victoria.

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Farewell Message

Ed and Pat Grey wish to thank all the people who have helped make our job as editors of *The Victorian Naturalist* over the past years rewarding, enjoyable and possible. There are far too many to list, but suffice it to say, we shall miss the contact with such a range of interesting and stimulating people. We are, however, happy to leave in the knowledge that the new editor – Merilyn Grey – will do a wonderful job.

Ed and Pat Grey

Plant Ecophysiology: the Quest to Understand How Plants Cope in a Changing Environment

Jann Williams[1] and Derek Eamus[2]

Abstract
Plant ecophysiology applies physiological principles and methodologies to organisms living in their natural environment. It is a relatively new field in Australia, but is helping unravel the linkages between pattern and process in a range of environments and vegetation types, and is providing basic information that can be used for managing natural resources. This paper reviews recent progress in the discipline and identifies future directions for research. (*The Victorian Naturalist* **116** (1), 1999, 6-10).

Introduction

Until recently, much ecological research into plants has been concerned with the description and classification of vegetation types, as well as the long tradition of assessing differences within and between populations of a plant species using morphological and demographic characters (Pryor 1956; Williams and Ladiges 1985). With the development of new approaches and methodologies, however, we are now gaining a greater understanding of the processes that underly the distribution and abundance of plants.

A more quantitative approach based on knowledge of mechanisms underlying the distribution and performance of plants can further improve understanding, and hence management of systems. Ecophysiology, a hybrid of physiology and ecology provides this approach. For the purposes of this paper, ecophysiology is considered to be the application of physiological principles and methodologies to organisms living in their natural environment, or the study of the influence of the environment on plant growth and development. It gives us the tools to advance our understanding of how plants cope with a changing environment on a daily, seasonal and annual basis.

Ecophysiology is a relatively new field in Australia (albeit a well established field in Europe and America), and is beginning to help unravel the linkages between pattern and process in range of environments and vegetation types (Williams and Eamus 1997). Pattern generally refers to the way plants are distributed in space and time across the landscape. For example, a species may only be found in locations where there is a reliable water supply, such as along river-banks. By examining the processes associated with these patterns, the aim is to identify the key mechanisms that help explain the distribution of individual plants or vegetation types. Using the previous example, the plants in question either may not be able to physiologically tolerate drier areas or could grow there but are outcompeted by other species. By using ecophysiological techniques, there is a greater chance of identifying which is the most likely explanation.

Recent published examples where ecophysiological principles are used to link pattern and process are studies on the dynamics of Mulga woodlands (Anderson and Hodgkinson 1997) and some of the pioneering work on northern Australian savannas (Prior *et al.* 1997; Myers *et al.* 1997). These studies provide considerable insight into the functioning of these ecosystems and provide basic information that can be used for the management of these landscapes. In addition, modelling physiological processes, as illustrated by studies on tree growth and nutrient cycling (Kirschbaum *et al.* 1994) can help predict potential changes in vegetation dynamics as environments change, for example in response to climate change (McMurtrie *et al.* 1992). Models can also inform our understanding of successional changes in vegetation after disturbances such as fire.

With the increasing realization of the importance of natural ecosystems to global environmental health (Mooney *et al.* 1996) and the increased focus on sustainable management (Commonwealth of Australia

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1996), the demand for information on the structure and functioning of ecosystems is likely to expand. The challenge is to provide informed opinions of the linkages between pattern and process and how ecosystems respond to the actions of humans (Williams and Eamus 1997). This paper indicates how the field of ecophysiology can help achieve an increased understanding of the links between pattern and process.

Plant ecophysiology – the links between pattern and process

The production of much of the vegetation covering the Australian continent is limited by low availability of water, nutrients, or both (Pate and McComb 1981). Superimposed on this axiomatic feature is the impact of fire upon vegetation structure and functioning. Availability of water, especially after fire, is a critical factor for plant distribution and performance. The challenge for ecophysiologists is to demonstrate how the different strategies used by plants for acquiring, controlling and using water and tolerating drought can explain observed patterns of vegetation structure and function.

In the recent special issue on plant ecophysiology in the *Australian Journal of Botany* (Volume 45(2)), competition for water was a constant theme across a range of ecosystems. For example, competition for water was central to the study by Anderson and Hodgkinson (1997), who showed, counter-intuitively, that grazing of perennial grasses around island-bands of Mulga *Acacia aneura* reduces the water supply to mulga shrubs, which then die during periods of low rainfall, leading to a dysfunctional landscape. In south-western Australia, competition for water was also important for the survival of *Hakea* species, especially at the seedling stage (Richards *et al.* 1997).

Pre-dawn water potential represents a measure of plant water status and soil water availability – the lower that water potentials are, the more stressed a plant is. In savanna woodlands in the Northern Territory (Myers *et al.* 1997; Duff *et al.* 1997), seasonal patterns in pre-dawn water potential have been related to phenology of a species, and to the micro-climate of the environment, especially vapour pressure deficit (VPD). Survival of species with different patterns of leaf-fall was apparently reliant upon differing 'strategies' and no single strategy appeared to confer a large competitive advantage.

Some of the variability and complexity of physiological responses in these savannas include identification of the different responses of saplings and trees of the same species in the one location (Prior *et al.* 1997; Myers *et al.* 1997) and different physiological responses between different populations of the same species (Fordyce *et al.* 1997). Complementary studies using stable isotopes to investigate water-use-efficiency of different provenances of River Red Gum *Eucalyptus camaldulensis* (e.g. Hubick and Gibson 1993) have shown that such approaches may be successful. Even so, the record of identifying physiological characters that may reflect underlying local adaptation remains modest, even though it has long been advocated (Williams *et al.* 1995).

While both too much and too little water can limit plant performance (Bell and Williams 1997), under certain conditions the amount of light received by a plant can also be a major source of stress. Environmental factors which disrupt leaf functioning, such as low temperatures, can induce a light-dependent loss in photosynthetic capacity known as photoinhibition (Osmond 1981). Cold-induced photoinhibition has been a major topic of biochemical and physiological research for the past fifteen years, but its significance for plant communities, both natural and agricultural, is still poorly known. Our understanding of the role of photoinhibition is slowly improving with an increasing number of field-based studies, as discussed in the next section of this paper.

Considerable benefits can also be gained by using ecophysiological techniques to examine the below-ground dynamics of plants, as illustrated by recent studies overseas (Vogt *et al.* 1996). In Australia our understanding of this area is still in the 19th century (Williams and Eamus 1997) with Keith (1997) identifying the following two areas as critical for future investigation: a) the factors controlling the amount of carbon and nutrients allocated within plants to below-ground parts (mostly roots) compared to above-ground

(shoots); and b) the transfer of nutrients from roots to the soil by living roots exuding substances or by the death of roots.

Field-based techniques

Recent technological advances have stimulated rapid progress in the discipline of ecophysiology and hence an increasingly process-based understanding is developing. In particular, recent developments in instrumentation (Pearcy *et al.* 1991) have caused a dramatic expansion of the number of projects involving physiological measurements in the field, allowing studies at more than one site and at greater frequencies. Thus, portable infra-red gas analysers and leaf diffusion porometers, coupled with data loggers for micro-climate studies, have allowed detailed investigations of the relationships between carbon assimilation, stomatal conductance and environmental factors. These instruments allow measurements of, for example, the amount of photosynthesis occurring in plants in the field, how much water a plant is using and measurements of the environment around a plant such as how much light it is receiving.

Methods and interpretation of gas exchange of terrestrial plants in the field have been advanced with the availability of equipment permitting automated control of light flux density, temperature and CO_2 concentration. Whole tree and canopy transpiration rates have become routinely measurable using a range of techniques (sap flow sensors; eddy correlation techniques). Indeed, in reviewing the field of ecophysiology, it is apparent that measurements at the individual tree scale, for above-ground parts, is adequately serviced by technology (Williams and Eamus 1997). Furthermore, the even newer sub-discipline of biochemical, or molecular ecology, is gaining ground – for example the developments in the use of genetically transformed plants to investigate whole plant nitrogen allocation and carbon gain (Stitt and Schulze 1994).

Technological developments in the measurement of photoinhibition *in situ* have also aided our understanding of the mechanisms underlying plant performance (Ball 1994; King and Ball 1998). Physiological studies indicate that species should be most vulnerable to photoinhibition near their distributional limits and that seedlings rather than established plants should be more vulnerable to reductions in growth associated with chronic photoinhibition. Thus, cold-induced photoinhibition may play a role in limiting regeneration, and hence also the distribution, of species along climatic gradients. Indeed, recent research has established that cold-induced photoinhibition is correlated with patterns of seedling regeneration by Snow Gum *Eucalyptus pauciflora* at tree line (Ball *et al.* 1991) and with poor growth of eucalypt seedlings planted in pasture revegetation programs (Holly *et al.* 1994; Ball *et al.* 1997). As the understanding of photoprotection and photodamage increases, the concept of light being a potentially overabundant resource may receive greater attention amongst ecologists.

Physiological techniques may be used to extrapolate to larger scale ecological questions. For example, Battaglia and Williams (1996) showed that the relative abundance of two eucalypt species at a given site in south-eastern Tasmania could be predicted by a knowledge of the depth and texture of soil at that site. These authors, in a similar manner to that of Eamus and Cole (1997), took observations at the large scale, and then initiated small-scale experiments to provide a mechanistic understanding of the processes generating large-scale patterns.

New technologies such as those described for terrestrial plants in Williams *et al.* (1997) and for aquatic organisms in Westphalen and Cheshire (1997) add to the growing number of tools that can be used to increase our understanding of pattern and process. The techniques used to measure hydraulic conductance and positive stem pressures in seedlings and resprouts in the Californian chapparal species *Adenostoma fasciculatum* could be usefully applied in ecophysiological studies in Australia.

Future Directions

Williams and Eamus (1997) identified two major challenges in the discipline of ecophysiology that are clearly deserving of attention. The first was the ecophysiology of below-ground parts (mostly, but not exclusively roots), while the second was to provide the catchment/regional scale answers and predictions that are required by managers and policy makers. Both chal-

lenges require an understanding of how plants respond to changing environments at a range of temporal and spatial scales. Furthermore, being able to meet the challenges will depend on the successful integration of two fields – modelling and remote sensing (see Moore *et al.* 1993) – because experiments at this scale (i.e. thousands of hectares) are not possible, and measurements of individual plants or animals would require vast amounts of replication (Williams and Eamus 1997).

Ecophysiological approaches can, however, currently be used to inform management practices. The diversity of ecophysiological responses in the Australian flora, which can be put to a wide range of applied uses, is a good case in hand. The selection of the best species to plant at a particular site can be greatly improved with good ecophysiological information, as identified by Bell and Williams (1997). For example, Walker *et al.* (1993) highlighted the need for details of water-use characteristics of species to be used for reclamation of degraded catchments. Efforts have been made in this direction (e.g. Bell *et al.* 1994), but progress is slow and the rehabilitation need is great. The lack of knowledge on the type of planting material, location of plantings and planting density have been identified as factors limiting major catchment revegetation programs in Australia (Schofield 1992). The need for more ecophysiological information is even more pressing in order to maximise the success of the major revegetation programs currently being promoted in Australia (Commonwealth of Australia 1997). A recent review of the ecophysiology of eucalypts (Bell and Williams 1997) also concluded that greater attention to ecophysiological interactions was needed to increase our understanding of the genus in both managed and natural systems.

An additional thrust for the future of ecophysiology lies in its penetration into and development with a range of other, more traditional, i.e. older, disciplines (Williams and Eamus 1997). For example, micrometeorologists are concerned with heat and momentum exchange between the planetary boundary layer and canopies and hydrologists need to know how vegetation influences catchment hydrology. Medium-scale (canopy, sub-catchment) and large-scale (regional, continental) processes will only become accessible when modellers and users of remote sensing and Geographic Information Systems (GIS) interact with ecologists and ecophysiologists on research projects at the landscape scale.

Conclusions

In highlighting ecophysiological research in Australia, the recent Symposia held in conjunction with meetings of the Ecological Society of Australia (see volumes 40(2) and 45(2) of the *Australian Journal of Botany*) have demonstrated that plant ecophysiology has a strong base in Australia. It is hoped that the discipline will continue to grow as the benefits of taking this approach become increasingly apparent and as new ways are developed to integrate the impact of physiological responses on the performance of a plant over its life. As the integration of small (leaf, tree), medium (canopy, sub-catchment) and large (regional, continental) scale studies increase, the contribution of knowledge of processes to explaining, predicting and managing patterns in the landscape will also increase.

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Flora of Australia
Volume 12 Mimosaceae (excluding *Acacia*), Caesalpiniaceae

Publisher: *CSIRO Publishing, P.O. Box 1139, Collingwood, Melbourne. RRP $69.95.*

This is the fourteenth angiosperm (flowering plant) volume to be published in the Flora of Australia series. Of the 59 volumes to be published in this major undertaking, 46 will deal with angiosperms and the remainder with the gymnosperm, fern, bryophyte, lichen and oceanic island floras.

A number of botanists, illustrators and photographers have contributed to this volume in which 169 native and naturalised species from 38 genera are described. All of the Australian genera in the Mimosaceae, with the exception of the largest, *Acacia*, and all 22 genera in the Caesalpiniaceae are described. The majority of species in these genera have a tropical to sub-tropical distribution although *Senna*, in particular, is a notable exception.

The Mimosaceae and Caesalpiniaceae are two of three legume families, the third being the very large Fabaceae (pea family). Some authorities treat these three families as sub-families of the Leguminosae.

This volume, like all volumes in this series, has been written by botanists for botanists and the style is formal. A good knowledge of plant descriptive terminology and nomenclatural terms and abbreviations is necessary if one is to fully appreciate this book, although the 64 excellent colour photographs add greatly to its attractiveness to the amateur. Descriptions and keys to genera and species are very concise but are supplemented with detailed and clear illustrations. Brief notes on distribution, rarity, taxonomic difficulties, horticultural value, weed status etc. are provided after each species description. For someone wishing to learn about any of the species in great detail, the treatments in this flora will serve as a useful starting point.

Distribution maps are placed together near the end of the book in the same order as the taxa appear in the descriptions. This, I think, works better than having the maps scattered throughout the text as has occurred in earlier volumes. This volume does not provide a key to angiosperm families or a glossary. These are provided in Volume 1.

Although very few of the species described in this volume occur naturally in Victoria, several are cultivated or occur as weeds. Some members of the Mimosaceae (tribe Mimoseae) are serious weeds, e.g. Mesquites (genus *Prosopis)*, introduced from America for their perceived benefits as soil stabilisers, food sources and stock shelter, and Sensitive plants of the genus *Mimosa*. A few species of *Albizia* (tribe Ingeae) are native to northern Australia and are related to the cultivated species of this genus that are grown in Victorian gardens. Cape Wattle *Paraserianthes lophantha* is native to southern Western Australia and is widely naturalised and cultivated in Victoria. One of the larger genera in the Mimosaceae treated in this volume is *Archidendron* which is distributed widely in Asia as well as in north-eastern Australia.

Familiar introduced species in the Caesalpiniaceae include Honey Locust *Gleditsia triacanthos*, a fodder plant introduced from North America and widely planted and naturalised, and Carob *Ceratonia siliqua*, which is also a useful food plant. The common garden plant, *Caesalpinia gilliesii*, has ten relatives that are native to northern Australia.

A genus in the tribe Cassieae of the Caesalpiniaceae that has been given special treatment in this volume is *Senna* (mostly formerly known as *Cassia*). It appears that taxonomic resolution of sections of this genus has been thwarted by such reproductive strategies as polyploidy, hybridisation and apomixis and this is discussed. In light of the lack of certainty about the current classification, the authors considered it best to identify some of the more problematic elements in the complex as 'form taxa' rather than as species or sub-species. The desert cassias of northern Victoria previously known as *Cassia nemophila* have been recognised as *Senna* form taxa '*coriacea*', '*zygophylla*', '*filifolia*' and '*petiolaris*'.

This book will be an excellent resource for professionals and may be useful for amateur botanists with a special interest in the Mimosaceae and Caesalpiniaceae.

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Leafhoppers in Ant Nests: Some Aspects of the Behaviour of Pogonoscopini (Hemiptera: Eurymelidae)

M.F. Day[1] and K.R. Pullen[1]

Abstract
Field and laboratory observations on a species of the leafhopper tribe Pogonoscopini have shown that it lives in nests of ants of the genus *Camponotus* during the day. At dusk it emerges, attended by the ants, to feed on mallee during the night. (*The Victorian Naturalist* **116** (1), 1999, 12-15).

Introduction

In the 1920s the north-western Mallee district was still a remote part of Victoria when Charles Oke, at that time an amateur entomologist with a particular interest in beetles, visited the railway siding of Gypsum and Hattah Lakes with J.E. Dixon. He described their excursion in a delightful essay published in *The Victorian Naturalist* (Oke 1926). About this time, a fascinating Australian fauna of insects and other invertebrates living as inquilines (guests) in ant and termite nests was being brought to light, and Oke had become an avid collector of the often bizarre inquiline beetles, discovering a diversity of new species. On this trip Oke found many beetles, but at Hattah Lakes he was also intrigued by 'a kind of froghopper (Cercopidae)' which he encountered in ant nests under the ground. The ant host was apparently the 'sugar ant', *Camponotus nigriceps* (Smith). Oke states the froghoppers 'were found in all stages, except the eggs. Little larvae from slightly more than 1 mm up to fully matured imagines (adults) were seen in the same nest....On rolling over the covering log from one of the nests sometimes a dozen or 20 of these guests will be revealed'. Several froghoppers were found at a depth of 'over 3 feet' (915 mm) in a large *Camponotus* nest 'covered by a log and a sheet of bark' that Oke excavated. Speculating on the habits of these inquilines, Oke said 'it would appear that they spent their lives in these nests - unless they are taken out at night to feed on the trees'. However, his brief observations at night did not reveal any froghoppers outside the nests. Oke did not identify his inquiline froghoppers, but we recognised them as one of the Pogonoscopini, a remarkable tribe of eurymelid leafhoppers.

The Pogonoscopini are poorly studied, distinctive and unusual insects confined, as far as is known, to the southern and interior parts of Australia. The history of the discovery and description of the species and their association with ants is worth recording. In 1909 Jacobi described two leafhoppers from the nests of sugar ants of the genus *Camponotus* from Western Australia; he accommodated the two in the existing eurymelid genus *Eurymeloides,* as *E. acmaeops* and *E. levis* (Jacobi 1909). In 1924 China described the new genus *Pogonoscopus* for a new species *P. myrmex*, and suggested that Jacobi's two species probably belonged to the same genus. China (1926) subsequently revised the group, describing several new genera and species to comprise a new subfamily, the Pogonoscopinae. Evans (1966) later referred to the group as the Tribe Pogonoscopini. Representatives of this unusual group were subsequently collected mainly by myrmecologists and almost always in the nests of *Camponotus*.

Yet the most basic aspects of pogonoscopine biology remained a mystery. They must have sucked sap like all leafhoppers, but where did they feed, and where were the eggs laid? Oke's observations shed no light on these questions. Evans (1931), apparently unaware of Oke's observations, was of the opinion that the pogonoscopines 'sucked up sap from below ground level', basing his comments on the advice of D.C. Swan, then in South Australia. Later, he stated unequivocally that the Pogonoscopini 'feed on the roots of eucalypts' (Evans 1946). In a subsequent revision of the Australian leafhopper fauna,

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Fig. 1. Mallee at Calperum. Characteristic of the habitat of *Pogonoscopus*.

Evans (1966) recognised five species of Pogonoscopini in four genera, placing several of China's species into synonymy. On the behaviour of these leafhopers, he quoted Mr Peter McMillan of Perth, who had frequently collected them with ants in Western Australia. McMillan wrote that the ants 'build their nests under logs and stones and have tunnels with large entrance holes which are smooth and vertical'. The leafhoppers 'walk around with a peculiar rolling motion and when escaping just fold their legs and tumble down the shaft'.

Field observations on *Pogonoscopus myrmex*

An opportunity to study a pogonoscopine species under field conditions arose when three leafhoppers identified as *Pogonoscopus myrmex* China were caught in traps set in mallee as part of a survey of the invertebrates of the Calperum sector of Bookmark Biosphere Reserve, South Australia (Pullen 1997). The collection site (Fig. 1), situated in the old Amalia paddock of the former Calperum sheep station, is dominated by Red Mallee, *Eucalyptus socialis* F.Muell. ex Miq. Calperum is located north of Renmark and has a semi-arid climate. The manner of collection of the specimens - two nymphs in pitfall traps and an adult female in a combination pitfall/flight intercept trap - dispelled the view that they passed their lives confined to ant nests.

We returned to the Amalia site on 12 October 1995 with the aim of observing *Pogonoscopus* and collecting additional material. Since previous ant collectors had found pogonoscopines most commonly in the nests of *Camponotus* at the base of eucalypts, the Amalia search was begun by excavating nests of *C. gouldianus* Forel located at the base of mallees. The nest tunnels invariably penetrated between the mallee roots, allowing only partial excavation, but after several hours five adults and one nymph of *P. myrmex* had been found, confirming *C. gouldianus* as a host ant. This work was carried out during daylight hours and no leafhoppers were seen outside the *Camponotus* nests.

Appreciating that *Camponotus* are night foragers, we returned to the site at dusk. We found many ants milling around the entrances to their nests and soon one or two pogonoscopines were observed. As darkness fell, more appeared, and eventually both nymphs and adults were seen to be climbing the mallee stems. The temperature was approximately 12-15°C. The pogonoscopines were noticeably more

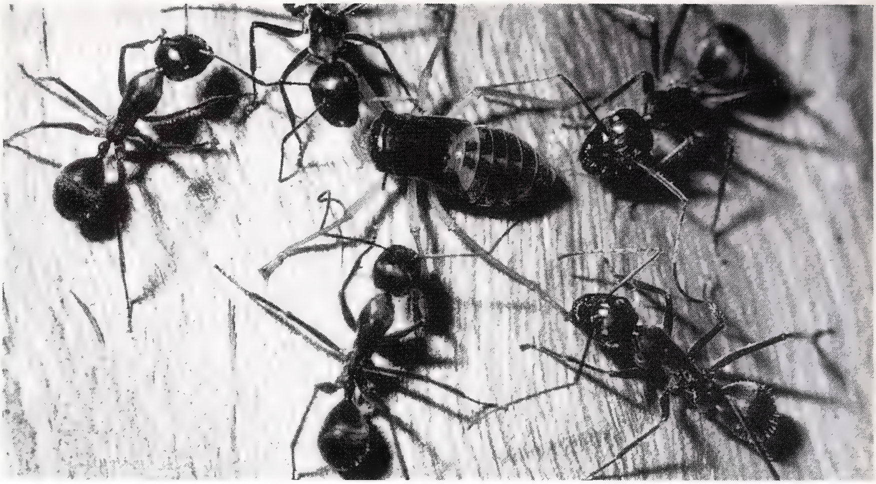

Fig. 2. A nymph of *Pogonoscopus myrmex* feeding at night on *Eucalyptus socialis* and attended by *Camponotus gouldianus*.

affected by the torch beams and moved faster than the ants, either to the far side of the trunk or more frequently under adhering bark. They were not 'herded', but moved independently of the ants, although ants attempted to follow any leafhoppers they encountered. Finally, at about 1930 hrs, some leafhoppers were seen to begin to feed, and then they were always attended by several ants (Fig. 2). During feeding, it was observed that the hind legs were often elevated and waved; the significance of this behaviour is not known. Most of the trees were above 3 m in height, so that, without ladders, it was not possible to see whether the leafhoppers ascended to the smaller branchlets. All nymphal stages and adults were present. Although they were more readily collected at night than during the day, they were not easy to capture because of their rapid movements and their aversion to light. The same behaviour was observed on the following night when the insects were photographed.

Laboratory observations on *Pogonoscopus myrmex*

Some nymphs and adult *P. myrmex* and their attendant ants were brought alive to Canberra where they survived for a week without food. Others were offered *Eucalyptus leucoxylon* F.Muell., on which they appeared to feed, even when the branchlets were considerably desiccated. To test the reaction of a local non-host *Camponotus* to their presence, several *P. myrmex* were placed in a previously prepared colony of *C.consobrinus* Erichson. The leafhoppers were vigorously attacked, with no evidence of any symbiotic relationship, inherent or otherwise.

Observations on *Australoscopus* sp.

During our stay at Calperum, a colleague Mr Michael Moore of Adelaide, returned from a day trip to Waikerie, South Australia, with live specimens of a second pogonoscopine, identified as a species of *Australoscopus*. The species is smaller than *Pogonoscopus myrmex* and was attended by *Camponotus terebrans* (Lowne) in a nest under cover on the ground. In culture, the ants on being disturbed were observed to pick up and carry the leafhoppers, behaviour noted by Oke (1926). On uncovering an ant nest, Oke observed that his froghoppers 'seem to be greatly agitated', and that 'any ant meeting one of the guests will immediately seize it by the thorax and carry it down one of the holes.... The ants invariably carry the leafhoppers off head foremost, and generally turn them over with their feet uppermost as soon as they take hold of them...' . To Oke it was evident 'that these froghoppers are used to being carried by the ants'.

It seems likely that the insect Oke was describing was a species of *Australoscopus*. We never observed *Camponotus gouldianus* carry *P. myrmex*.

Discussion

Our observations demonstrated that *Pogonoscopus myrmex* is not confined to ant nests and that, while feeding, its behavioural interaction with its ant host is comparable to that of other eurymelids (Evans 1931; Buckley 1987), except that *P. myrmex* feeds at night. Diurnal ant inquilinism and nocturnal foraging may be a strategy that allows *Pogonoscopus* to avoid both predation and the hot, desiccating diurnal conditions where it lives.

In most characters, such as their mouthparts, antennae, leg structure and fully developed wings, the Pogonoscopini are typically eurymeline. However, neither the nymphs nor adults are capable of jumping, so that 'leafhopper' is an inappropriate name for these insects. The unusually long legs of all stages, even 1st instar nymphs, have been mentioned in all previous reports, several authors referring to their 'spider-like' appearance. The long legs could be an adaptation to allow an easier daily trip from the host ants' nest up to the mallee branches and return. It would be of interest to learn whether the young nymphs travel long distances walking, both after hatching from the egg and to feed; such travel would represent a substantial feat.

Pogonoscopus myrmex does not appear to exhibit special myrmecophile adaptations for permanent life in ant nests. Myrmecophiles typically have the eyes reduced or absent, and the epidermis is often unpigmented. To avoid injury by their ant hosts they are often rapid runners (e.g. Thysanura, Staphylinidae) or are able to retract the antennae and legs into grooves in the body integument (e.g. many inquiline beetles).

The fat body of both adults and immature stages of pogonoscopines is very well developed, possibly an adaptation necessary to hold them over on occasions when, perhaps due to weather conditions, the insects are unable to leave the host ant nest to feed.

The observations noted above show that significant differences exist between pogonoscopine genera in their behavioural relationships with their host ants. Much of the life history of these inquiline leafhoppers remains completely unknown. We do not know where or at what time of the year the eggs are laid, or where the early instars live. If the eggs are inserted into the twigs or stems of the host plant, as in other eurymelids, how do the nymphs reach the nest of a host ant? We know nothing of the behaviour of the other three described pogonoscopine species. An interesting study awaits a future student.

Acknowledgements

We thank Mr Bruce Lambie, now of the Australian Heritage Commission, Canberra, for facilitating access to Calperum and the Bookmark Biosphere Reserve; Dr Steve Shattuck, CSIRO, and Mr Archie McArthur, SA Museum, for ant identifications; Dr Michael Braby, CSIRO, for photography; and Mr Mike Moore, Adelaide, for specimens of *Australoscopus*.

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The Orange Palm Dart Skipper *Cephrenes augiades sperthias* (Felder) in Melbourne

John Eichler[1]

Abstract

This article provides additional locality records of the Orange Palm Dart Skipper *Cephrenes augiades sperthias* (Felder); Lepidoptera: Hesperiidae, in suburban Melbourne, lists larval food plants and includes observations of its life cycle. (*The Victorian Naturalist* **116** (1), 1999, 16-18).

Distribution and Range Extension

The Orange Palm Dart is a relatively large skipper, whose larvae feed exclusively on palms.Its natural range is eastern coastal Australia, from Cape York to the Illawarra region of New South Wales (Common and Waterhouse 1981). By the early 1980s it had become naturalised in the Perth region of Western Australia (Hutchison 1983). In 1990, Crosby recorded specimens from Camberwell, Victoria. He concluded that they had probably developed from eggs transported from Queensland on palms and that the Orange Palm Dart was unlikely to become established in Victoria. However, subsequent records from the inner eastern suburbs led Crosby (1994) to conclude that it had become established in Melbourne.

Larvae were first noted on a small Bangalow Palm *Archontophoenix cunninghamiana* in my garden in the Melbourne bayside suburb of Black Rock on 5 February, 1994 and successive generations of Palm Darts have continued to use that palm. The identity of the insect was established by raising butterflies from the pupal stage and comparing male and female adults with the illustrations and descriptions in Common and Waterhouse (1981) and McCubbin (1971).

Later in February 1994, larvae and pupae were found in a nearby garden on numerous species of palm. Larvae had been known from that site since about 1992 (David Radford *pers. comm.*). Subsequent searches revealed that the Orange Palm Dart was present elsewhere at Black Rock, at the nearby suburbs of Beaumaris and Sandringham and at Mitcham. David Britton (*pers. comm.*) recorded the Palm Dart at Kew in 1992 and 1993 and has noted larval shelters in West Melbourne.

Crosby (1994) reported a number of observations of the Orange Palm Dart from Melbourne suburbs, including East Melbourne and South Yarra, during 1990 to 1993.

Description

Cream coloured eggs are laid singly on various parts of palm plants. The larval and pupal stages can be found in cylindrical shelters, which the insect forms by joining together the margins of palm leaflets with silk. Larvae observed at Black Rock are up to 50 mm long, are light green in colour and often have two yellow spots on their back. They have a broad, cream coloured head with brown stripes. Male and female butterflies are quite different in their appearance, the following descriptions being based on Black Rock specimens. Males have a wingspan of approximately 35 mm and are brightly coloured with orange and dark brown patches. Females are an almost uniform dark brown colour and are larger, having a wingspan of approximately 40 mm. The source of those insects may be from Queensland, where females tend to be darker than those from New South Wales (Common and Waterhouse 1981).

Larval Food Plants

In Melbourne, Orange Palm Dart larvae feed on a number of Australian and exotic palms which are listed in Table 1.

Dunn (1995) records 75 palms that are larval hosts of the Orange Palm Dart in Queensland. Crosby (1994) records 5 species of palm that are used in Melbourne, of which the introduced Queen Palm *Arecastrum romanzoffianum* and Senegal Date Palm *Phoenix reclinata*, are additional to the species listed in Table 1.

[1] 18 Bayview Crescent, Black Rock, Victoria 3193.

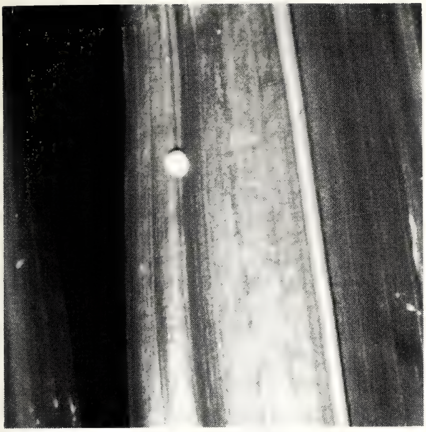

Fig. 1. Egg on upper side of Bangalow Palm leaflet.

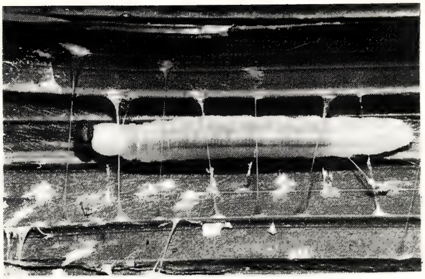

Fig. 2. Larva in opened Bangalow Palm leaflet shelter.

Fig. 3. Pupa in opened Bangalow Palm leaflet shelter.

Fig. 4. Adult male on Kentia Palm frond.

Life Cycle Observations and Comments

The following observations were made of the Palm Dart's life cycle in Melbourne.

- Larvae were noted during February, March, April and July.
- Pupation was observed in February and March. The pupation period recorded for pupae kept indoors ranged from 19 to 24 days (four observations).
- Female butterflies were seen in January and March. A male butterfly was found sheltering in a wood pile in May. David Britton (*pers. comm.*) recorded a female in May and a male in April.
- Freshly laid eggs were found on the leaflets, crown shaft (frond base) and trunk of a Bangalow Palm in December, January and March.

The Orange Palm Dart is able to survive Melbourne's winters and is still active during cooler months. At first this seems surprising given its tropical to sub tropical origin. It appears that the lack of suitable larval food plants has been more of a limiting factor than climatic conditions, at least in southern Victoria. Other Australian butterflies, e.g. the Dingy Swallowtail *Papilio anactus* and Orchard Butterfly *Papilio aegeus aegeus*, have also been able to extend their range southwards into Victoria because trees have been planted that are eaten by their larvae (McCubbin 1971). A possible explanation for the Palm Dart's activity during cooler months is that it has not yet adapted to climatic conditions in Melbourne.

Conclusions

The Orange Palm Dart is an adaptable insect whose spread to Melbourne coincides with, and presumably is a result of, the increased use of palms in landscaping since the 1980s.

Because the larvae feed exclusively on palms, it is assumed that this new insect

Table 1. Records of larval food plants, Melbourne.

Australian Palms	Exotic Palms
Alexandra Palm *Archontophoenix alexandrae*	European Fan Palm *Chamaerops humilis* (Mediterranean)
Cabbage Fan Palm *Livistona australis*	Canary Island Date Palm *Phoenix canariensis* (Africa)
Bangalow Palm *Archontophoenix cunninghamiana*	Canary Island and Senegal Date Palm hybrid *Phoenix canariensis x reclinata* (Africa)
Umbrella Palm *Hedyscepe canterburyana* (Lord Howe Island)	Dwarf Date Palm *Phoenix roebelenii* (South East Asia)
Kentia Palm *Howea forsteriana* (Lord Howe Island)	Nikua Palm *Rhopalostylis sapida* (New Zealand)
	Chinese Windmill Palm *Trachycarpus fortunei* (Himalayas)
	Washington Palm *Washingtonia robusta* (USA)

arrival will have little or no adverse impact on indigenous insects or plants in most of Victoria, although it would be interesting to know whether it is present in the stands of Cabbage Fan Palms *Livistona australis* near Orbost.

Acknowledgments
Thanks to Pat and Mike Coupar, who tentatively identified the larvae, later confirmed the identity of adults and referred me to the 1990 Crosby article, David Radford, who identified many of the larval food plants and was able to recall when larvae first appeared in his garden and David Britton, who provided some additional records and helpful comments on an earlier draft.

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Vale
Joan Harry

Joan Harry died on Saturday, October 17, 1998. She suffered from a brain tumour over a nine year period.

When Marie Allender retired as General Excursion Secretary in February, 1990, Joan took over the job and served for about six months, when she had to stop for her first brain tumour operation. Dorothy Mahler then acted temporarily as Acting Excursion Secretary for Joan. However, as Joan convalesced over an extended period, she was unable to resume the position.

In late 1991, Joan was feeling well enough to serve as Chairperson of the Botany Group, after Margaret Potter who had stepped down after many years in that position. Joan held that position for three years until Tom May (present FNCV President) was elected Botany Group Chairperson in December 1994.

Joan was always supportive of working bees, often acting as tea/coffee lady in the kitchen, especially when we were folding the newsletter or after meetings in the evenings at the Hall. She was always a dedicated and helpful club member until she had to drop out over a year ago because of illness. Over the years she also attended most of the excursions and tours organized by the club.

Noel Schleiger represented the FNCV at her funeral on Wednesday, October 21, 1998. The Club extends its sympathy to husband Graeme, and family.

Noel Schleiger and Dorothy Mahler

A Fauna Survey of Riparian and Other Revegetation Sites in Eltham, Victoria

Peter Homan[1]

Abstract
A fauna survey of revegetation sites was carried out over a six-month period in 1996 in Eltham, a north-east suburb of Melbourne with eleven mammals, fifty-six birds, eight reptiles and five amphibians being recorded. Results of the study showed an absence of small terrestrial native mammals and invasion of revegetated areas by introduced species. (*The Victorian Naturalist*, **116** (1), 1999, 19-25).

Introduction

Lenister Farm is located in Homestead Road, Eltham, approximately 28 kms north-east of Melbourne Central, within the Melbourne metropolitan area, on the southern edge of Eltham Lower Park, near the junction of the Yarra River and Diamond Creek. The property was originally a dairy farm, but is now owned by the Shire of Nillumbik and is leased to PEEC Services Inc., a private training provider.

For some years PEEC Services (formally Skill Seekers) has conducted horticultural training at the farm and, since April 1993, has been involved in a long term riparian revegetation project along Diamond Creek and the Yarra River in conjunction with the Shire of Nillumbik. Revegetation work has also been carried out by Friends of Diamond Creek, a local volunteer group, while other habitat enhancement work has also been completed including the removal of woody weeds from Hohnes Hill, a small nature reserve of about 5 ha on the western edge of the study area. An indigenous plant nursery is also located at the farm and helps to provide stock for the revegetation program.

This survey was carried out to determine which species of mammals, birds, reptiles and amphibians now inhabit the general area around Lenister Farm and, in particular, the revegetation sites along Diamond Creek and the Yarra River and at Hohnes Hill (Fig. 1).

Vegetation and topography

The study area covers approximately 23 ha and is bounded by Main Road, Eltham to the north, Diamond Creek to the east, Yarra River and Homestead Road to the south and Jayson Avenue to the west.

Much of the study area is on a flood plain at the junction of the two streams and also includes several small gully systems and three small artificial wetlands, while the highest point is on Hohnes Hill, 60 m above sea level. A large artificial wetland has since been constructed on the flood plain beside the Yarra River.

Eltham Lower Park includes two sports ovals, the Diamond Valley Miniature Railway and a pony club. A public walking track leads along the two streams, which attracts large numbers of walkers, joggers and local residents walking dogs.

Vegetation in the park includes remnant mature Candlebark *Eucalyptus rubida*, Yellow Box *E. melliodora*, Long-leaved Box *E. goniocalyx* and Narrow-leaved Peppermint *E. radiata*. Hollows are numerous amongst these mature trees.

The riparian vegetation along Diamond Creek and the Yarra River includes Manna Gum *Eucalyptus viminalis*, Silver Wattle *Acacia dealbata*, with remnant stands of River Bottlebrush *Callistemon sieberi*,

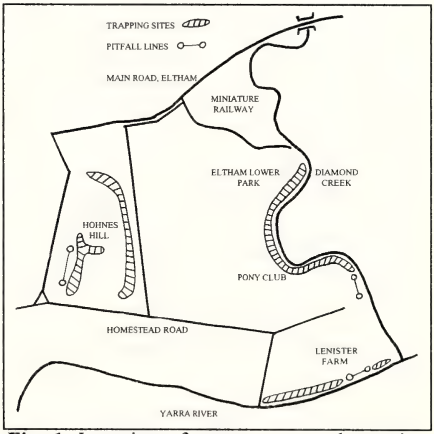

Fig. 1. Location of survey area and trapping sites. Melway Map 21, J11.

[1] 8 Bayfield Drive, Eltham, Victoria 3095.

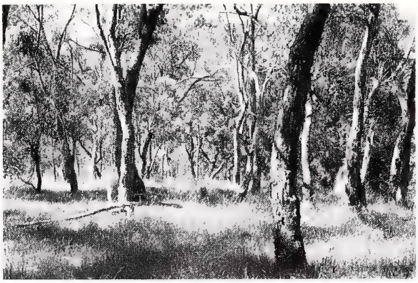

Fig. 2. Grassy eucalypt woodland, Hohnes Hill.

Tree Violet *Hymenanthera dentata*, Burgan *Kunzea ericoides,* Kangaroo Apple *Solanum laciniatum*, Dogwood *Cassinia aculeata,* Hop Goodenia *Goodenia ovata*, Spiny-headed Matrush *Lomandra longifolia* and *Poa ensiformis*. All of these species have been used extensively in the revegetation program along both streams. Unfortunately various introduced species have infested the riparian zone including Spider Wort *Tradescantia fluminensis*, Angled Onion *Allium triquetrum*, Blackberry *Rubus procerus*, Hawthorn *Crataegus monogyna*, Crack Willow *Salix fragilis* and *Watsonia bulbillifera*.

Hohnes Hill Flora Reserve is an area of grassy woodland (Fig. 2) with Yellow Box *E. melliodora*, Long-leaved Box *E. goniocalyx*, Candlebark *E. rubida,* Red Stringybark *E. macrorhyncha*, Manna Gum *E. viminalis*, Burgan *K. ericoides*, Sweet Bursaria *Bursaria spinosa*, Golden Wattle *Acacia pycnantha*, Hedge Wattle *A. paradoxa,* Tree Violet, Cherry Ballart *Exocarpus cupressiformis* and *Clematis microphylla*. Grasses include Tussock Grass *Poa sieberiana*, Wallaby Grass *Danthonia* spp. and a range of introduced grasses that have invaded large areas of the reserve. Various native orchids including Greenhoods and Spider Orchids persist in reasonable numbers in the southern end of Hohnes Hill. Many of the Eucalypts are mature with numerous hollows.

Survey methods

The survey was conducted between May and November 1996, from Monday to Friday of each week.

Survey methods included: cage trapping (Wiretainers standard bandicoot trap) placed on the ground and in trees; Elliott trapping (Type A); pitfall trapping (plastic buckets, 380 mm in depth and 285 mm in diameter); an artificial nest box program and general observation and collection. Baits consisted of oats, peanut butter, honey and vanilla essence. Artificial shelters were also used to survey amphibians. These were made from 23 mm treated pine and measured 600 mm × 400 mm and were raised off the ground by slats of pine of the same thickness along three edges, therefore allowing frogs to move under the shelter from one side. These shelters were placed around several wetlands with the entrance facing the water and were turned over for inspection daily.

Only a minimal amount of spotlighting was carried out (a total of six spotlight hours) and general observation and collection took place on a daily basis.

Trapping took place on Monday, Tuesday and Wednesday nights only. On various occasions trapping was not undertaken due to inclement weather and the water level in both streams. Trapping along the Yarra River and Diamond Creek took place in a narrow riparian corridor between each stream and the public walking track (Fig. 1). Because much of the area is used extensively by the public, traps were set randomly and in a somewhat clandestine fashion, so as to avoid possible theft or interference with equipment. Consequently on some nights only small numbers of traps were set.

Overall 707 trap-nights and 293 pit-nights were completed. Table 1 shows the trapping methods used and effort for each section of the study area.

Artificial nest boxes were designed to survey the presence of Sugar Gliders in the area and to provide breeding records for small parrots. Four Sugar Glider boxes were placed in Hohnes Hill and seven were placed along Diamond Creek. Five small-parrot boxes were placed in the southern section of Eltham Lower Park and along Diamond Creek.

All nest boxes were constructed of 19 mm exterior grade ply with an internal diameter of 240 mm and a depth of 420 mm. Entrance holes, which were 50 mm for Sugar Gliders and 70 mm for small parrots, were 300 mm above the floor.

Table 1.

	Trap-nights			Pit-nights	Total
	Cage traps on ground	Cage traps in trees	Elliott traps on ground		
Hohnes Hill	nil	23	59	178	260
Diamond Creek	182	nil	54	80	316
Yarra River	320	nil	69	35	424
All Sections	**502**	**23**	**182**	**293**	**1000**

Results

Since intensive surveys such as this are unusual, particularly within the metropolitan areas of large cities, the results of this survey therefore give a fair indication of those species that may exist in other urban areas with suitable habitat, especially those areas that have undergone revegetation projects.

A total of eighty vertebrate species were recorded during the survey. These were made up of eleven mammals (five eutherian, five marsupial, one monotreme; seven native, four introduced) fifty-six birds (fifty-one native, five introduced), eight reptiles and five amphibians. Fourteen species of birds were also recorded as breeding in the study area. Because the bulk of the survey took place during the winter months no harp-trapping for insectivorous bats took place and a number of birds that would be expected to visit areas such as this during the warmer months were also not recorded.

Cogger (1996), Menkhorst (1995) and Simpson and Day (1996) were used for species names.

Survey codes are the same as used by the Atlas of Victorian Wildlife:

B Breeding confirmed (birds: nest with eggs; or dependent young out of nest)
S Seen
H Heard
T Trapped and released
I Indirect evidence eg. Tracks or traces, including scats, burrows, diggings.

Mammals

1. Bat, White-striped Freetail **Tadarida australis, *H.*** One individual was heard flying above trees along Diamond Creek whilst spotlighting on 8/10/96.

2. Fox, Red **Canis vulpes, *S.*** One sick/injured individual was seen near Hohnes Hill on 4/6/96 and subsequently one, presumably it, was found dead on 5/6/96.

3. Glider, Sugar **Petaurus breviceps, *S.*** Three individuals were disturbed from a stag at Hohnes Hill on 15/5/96. No animals were captured during trapping in trees at Hohnes Hill and none were seen during spotlighting on 8/10/96. Nest boxes were not used by this species during the survey.

4. Mouse, House, **Mus musculus, *T.*** Twenty-one house mice were captured in Elliott traps, seventeen in the oldest revegetation site (1993) along the Yarra River, one in revegetating *Poa ensiformis* along Diamond Creek and three in grassy woodland at Hohnes Hill. Two house mice were also caught in pitfall traps along the Yarra (capture rate 5.7%) The capture rate for Elliott traps along the Yarra River was 24.6%, along Diamond Creek was 1.8% and for Hohnes Hill was 5%.

5. Platypus **Ornithorhynchus anatinus, *S.*** Platypus were seen in the Yarra River at the same location near its junction with Diamond Creek on three occasions, at 2.55pm on 4/9/96, at 10.30am on 5/9/96 and at 11.00am on 23/10/96.

6. Possum, Common Brushtail **Trichosurus vulpecula, *T.*** This was the most common native mammal encountered during the survey. Fourteen individuals were caught in cage traps set on the ground along the Yarra River. Cage trap capture rate overall was 3.8% and along the Yarra River was 4.4%. At Hohnes Hill the capture rate in cage traps set in trees was 8.7%. However, other substantial indirect evidence occurred including scats and scratch marks on trees. Several animals were also seen during the day in hollows throughout the study area. Seven adults and two juveniles were seen during six spotlight hours on 8/10/96.

7. Possum, Common Ringtail, **Pseudocheirus peregrinus, *S.*** Many individuals of this species were seen in dreys during the day along both streams,

Fig. 3. Water Rat *Hydromys chrysogaster* capture site on the Yarra River.

however, none were captured in cage traps during the survey. Eight Ringtails were seen during six spotlight hours on 8/10/96.

8. Rabbit **Oryctolagus cuniculus,** *S.* Many individuals were seen in all parts of the study area, with a marked reduction in sightings during the second half of the study. A number of dead animals were found during September and October.

9. Rat, Black **Rattus rattus,** *T.* This was the most common terrestrial mammal caught amongst the riparian vegetation along both streams. Twenty individuals were caught along the Yarra River, and thirteen along Diamond Creek. Overall capture rate for these sites was 5.9%, with 6.3% for the Yarra River and 7% for Diamond Creek. Individuals were caught in both degraded areas and revegetated sites. No captures occurred at Hohnes Hill.

10. Rat, Water **Hydromys chrysogaster,** *T.* This was the only native rodent recorded during the survey. Thirteen individuals, six males and seven females, were caught in cage traps set along the Yarra River (Fig. 3) and Diamond Creek. Eleven animals were caught along the Yarra River adjacent to the oldest revegetation site, and two animals were caught along Diamond Creek near remnant *Poa ensiformis* and *Callistemon sieberi*. The majority of captures along the Yarra (nine) occurred in late June and early July, with the remaining two in late September. The two captures along Diamond Creek took place in late August. Overall capture rate was 2.8%, with 3.4% for the Yarra River, and 1% for Diamond Creek. Weight for males varied from 630 g to 1060 g (average 786 g) and for females, from 650 g to a pregnant animal (caught 25/9/96) weighing 1000 g (average 747 g).

11. Wombat, Common **Vombatus ursinus,** *I.* No Wombats were seen during the study, however, substantial indirect evidence was found regularly in the form of active burrows, scratchings and scats.

Birds

Table 2 lists the birds that were recorded in the study area.

Reptiles

1. Lizard, Blotched Blue-Tongued **Tiliqua nigrolutea,** *S.* One individual was found at Hohnes Hill on 1/8/96.

2. Lizard, Eastern Blue-Tongued **Tiliqua scincoides,** *S.* One individual was found near Diamond Creek on 28/8/96.

3. Skink, Garden **Lampropholis guichenoti,** *T.* This was the most common and widespread reptile encountered during the study. Individuals were sighted during each month of the survey, in particular on sunny days. Twelve Garden Skinks were captured in pitfall traps, five at Hohnes Hill (capture rate, 2.8%), five along Diamond Creek (capture rate, 6%) and two along the Yarra River (capture rate, 6%).

4. Skink, Water **Eulamprus** *sp.*, *S.* One individual was seen by the Yarra River on 16/9/96 and two along Diamond Creek on 8/10/96.

5. Skink, Weasel **Saproscincus mustelinus,** *S.* Three found under heavy leaf litter amongst Spider Wort along Diamond Creek, one on 15/5/96 and two on 2/7/96. No individuals of this species were captured in pitfall traps.

6. Snake, Eastern Brown **Pseudonaja textilis,** *S.* One individual seen at Hohnes Hill on 11/10/96.

7. Snake, Eastern Tiger **Notechis scutatus,** *S.* One individual seen near farm on 16/10/96.

8. Turtle, Eastern Snake-necked **Chelodina longicollis,** *S.* One seen in Diamond Creek on 7/11/96 and three more in Diamond Creek on 8/11/96.

Table 2. Bird species recorded at the study area.

Blackbird, Common *Turdus merula*, **S, B**
Bronzewing, Common *Phaps chalcoptera*, **S**
Butcherbird, Grey *Cracticus torquatus*, **S, B**
Cockatoo, Yellow-tailed Black *Calyptorhynchus funereus*, **S**
Cockatoo, Gang-gang *Callocephalon fimbriatum*, **S**
Cockatoo, Sulphur-crested *Cacatua galerita*, **S**
Corella, Long-billed *Cacatua tenuirostris*, **S**
Cormorant, Little Pied *Phalacrocorax melanoleucos*, **S**
Cormorant, Great (Black) *Phalacrocorax carbo*, **S**
Cormorant, Little Black *Phalacrocorax sulcirostris*, **S**
Cuckoo, Fan-tailed *Cuculus flabelliformis*, **S**
Cuckoo-shrike, Black-faced *Coracina novaehollandiae*, **S**
Currawong, Pied *Strepera graculina*, **S**
Currawong, Grey *Strepera versicolor*, **S**
Darter *Anhinga melanogaster*, **S**
Duck, Pacific Black *Anas superciliosa*, **S**
Duck, Australian Wood (Maned) *Chenonetta jubata*, **S, B**
Fairy-wren, Superb *Malurus cyaneus*, **S**
Fantail, Grey *Rhipidura fuliginosa*, **S**
Frogmouth, Tawny *Podargus strigoides*, **S**
Galah *Eolophus (Cacatua) roseicapilla*, **S**
Goshawk, Brown *Accipiter fasciatus*, **S**
Heron, White-faced *Egretta (Ardea) novaehollandiae*, **S, B**
Heron, Rufous Night *Nycticorax caledonicus*, **S**
Ibis, Australian White (Sacred Ibis) *Threskiornis molucca (T. aethiopica)*, **S**
Ibis, Straw-necked *Threskiornis spinicollis*, **S**
Kingfisher, Azure *Alcedo azurea*, **S**
Kingfisher, Sacred *Todiramphus sanctus*, **S**
Kite, Black-shouldered *Elanus axillaris*, **S**
Kookaburra, Laughing *Dacelo novaeguineae*, **S**
Lapwing, Masked *Vanellus miles*, **S**
Lorikeet, Rainbow *Trichoglossus haematodus*, **S, B**
Magpie, Australian *Gymnorhina tibicen*, **S, B**
Magpie-lark *Grallina cyanoleuca*, **S, B**
Miner, Bell *Manorina melanophrys*, **H**
Miner, Noisy *Manorina melanocephala*, **S, B**
Moorhen, Dusky *Gallinula tenebrosa*, **S**
Myna, Common *Acridotheres tristis*, **S, B**
Oriole, Olive-backed *Oriolus sagittatus*, **S**
Pardalote, Spotted *Pardalotus punctatus*, **S**
Parrot, Australian King *Alisterus scapularis*, **S**
Parrot, Red-rumped *Psephotus haematonotus*, **S**
Raven, Australian *Corvus coronoides*, **S**
Rosella, Crimson *Platycercus elegans*, **S**
Rosella, Eastern *Platycercus eximius*, **S, B**
Scrubwren, White-browed *Sericornis frontalis*, **S, B**
Shrike-thrush, Grey *Colluricincla harmonica*, **H**
Starling, Common *Sturnus vulgaris*, **S, B**
Swallow, Welcome *Hirundo neoxena*, **S**
Teal, Chestnut *Anas castanea*, **S**
Thornbill, Brown *Acanthiza pusilla*, **S, B**
Thrush, Song *Turdus philomelos*, **S**
Turtle-Dove, Spotted *Streptopelia chinensis*, **S, B**
Wagtail, Willie *Rhipidura leucophrys*, **S**
Wattlebird, Red *Anthochaera carunculata*, **S**
Whistler, Golden *Pachycephala pectoralis*, **S**

Amphibians

*1. **Frog, Brown Tree*** **Litoria ewingi, *S.*** Several individuals were found amongst plant pots at nursery adjacent to the farm. One also found at new wetland at Miniature Railway on 17/9/96.

*2. **Frog, Eastern Banjo*** **Limnodynastes dumerilii, *T.*** Several individuals found near farm and others heard calling on numerous occasions in several man-made and natural wetland areas. Six Eastern Banjo Frogs were captured in pitfall traps at Hohnes Hill (capture rate, 3.3%). One was also found under an artificial amphibian shelter on 2/10/1996.

*3. **Frog, Spotted Grass*** **Limnodynastes tasmaniensis, *T.*** Two individuals were found in new wetland near Diamond Creek on 6/6/96, and one was caught in a pitfall trap at Hohnes Hill on 4/9/96 (capture rate, 0.5%).

*4. **Frog, Verreaux's Tree*** **Litoria verreauxii, *S.*** One individual found near the farm on 28/8/96.

*5. **Froglet, Common Eastern*** **Crinia signifera, *S.*** This species was the most common amphibian encountered during the study, and readily occupied the artificial amphibian shelters placed around wetlands. Common Eastern Froglets were heard calling on many occasions in all wetland areas and individuals were found covering the various colour ranges.

Nest box program results

Hohnes Hill: Four nest boxes designed for sugar gliders were placed at this site on 3/6/96. They were first checked on 1/7/96 and were unoccupied, however, each entrance hole had been marked. They were checked again on 8/10/96 and each box was found to contain a nest of the Common Starling.

Diamond Creek and Eltham Lower Park: Twelve nest boxes were placed in these areas, four on 5/6/96, four on 1/8/96 and four on 19/8/96. Five of these boxes were designed for small parrots and seven for sugar gliders. All twelve boxes were checked on 9/10/96 and seven were found to contain Starling nests, one contained the nest of a Common Mynah, one contained

the nest of an Eastern Rosella (one egg) and three were unoccupied.

Discussion

The study site is typical of areas very close to suburban housing that have become heavily degraded by a range of invasive weeds. Much of the original understorey, shrub layer and ground cover has disappeared and in most of the study area only the tree cover remains.

The avifauna in the area is dominated by the aggressive Noisy Miner. Dr. Douglas Dow, Queensland University (Pizzey 1991), found the Noisy Miner's unpleasant trait of directing loud, concerted aggression against almost every other bird unfortunate enough to enter its territory makes it unique among birds and possibly among all known animals. Noisy Miners were seen to chase and harass nearly every other species observed during the survey. As with other areas dominated by this species, no small honeyeaters were recorded during the study. The White-plumed Honeyeater, a species common throughout Melbourne, was not seen during the study. This species is also absent from other parts of Eltham where Noisy Miners occur in numbers. Small birds such as the Superb Fairy-wren and the White-browed Scrubwren were confined to the few areas with thick undergrowth along the banks of the two streams. The Rufous Whistler *Pachycephala rufiventris,* a species that would be expected to arrive in areas such as this during early spring (Simpson and Day 1996), was not recorded during the study.

The oldest revegetation site (1993) along the Yarra River is inhabited by the Black Rat, House Mouse and Common Wombat. A drey, occupied by a ringtail possum, was also found at this site in an old Tree Violet and Superb Fairy-wrens, White-browed Scrubwrens and Brown Thornbills were often seen at this location. Several Noisy Miner nests and one Blackbird nest were found in revegetated areas and Brown Thornbills with dependant young were observed in a revegetation area along Diamond Creek. Jute-matting has been used extensively to suppress weeds in the revegetation sites and many Garden Skinks were found under this material, however, Weasel Skinks were only found under heavy litter amongst Spider Wort, and none were found in the revegetation areas. Water Skinks were observed close to both streams at two sites, one degraded and one rehabilitated. There were no amphibians recorded for any of the riparian revegetation sites, however, Eastern Banjo Frogs, Spotted Grass Frogs, Common Eastern Froglets and Brown Tree Frogs were found in, and heard calling at, artificial wetlands.

No small terrestrial native mammals were recorded for the study area and the only native rodent recorded was the aquatic Water Rat. The introduced Brown Rat *Rattus norvegicus* was not found during the survey. On several occasions Koalas *Phascolarctos cinereus* were observed in Manna Gum on the Templestowe (south) side of the Yarra River, however, none were seen in the study area. No evidence of Echidnas *Tachyglossus aculeatus* was found during the survey, although this species has been recorded in other parts of Eltham (Menkhorst 1995).

The large number of hollows in the area are used extensively by the introduced Common Mynah and English Starling. Several trees and hollow limbs fell during the time of the survey, many of which contained disused Mynah nests constructed with plastic and other man-made materials, items commonly used as nesting material by this species (Beruldsen 1980). Starlings were seen to enter several hollows during the breeding season and their dominance of the artificial nest boxes was overwhelming. European bees were also seen to occupy several hollows. However, all the parrots (except the Yellow-Tailed Black Cockatoo) observed during the survey were seen entering hollows at various times, but breeding could only be confirmed for the Eastern Rosella (nest box) and the Rainbow Lorikeet (dependant young out of nest at Hohnes Hill).

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Environment. The Shire of Nillumbik, as the local land manager, provided important advice and assistance. Equipment for pitfall traps was lent by the Fauna Survey Group, FNCV. and several members of the group including Ray White, Russell Thompson and Ray Gibson provided valuable advice.

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Climate Change 1995 – Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses

Editors Robert T. Watson, Marufu C. Zingowerd, Richard H. Moss and David J. Dokken

Publisher: *Cambridge University Press, Melbourne. Paperback, 880 pp. ISBN 0521564379. RRP $57.95*

This comprehensive volume provides a roadmap for navigating the sometimes divisive public debate about the consequences of climate change. It reviews what is known, unknown, uncertain and controversial about the potential impacts of climate change and finds that:

- the composition and geographic distribution of many ecosystems will shift;
- some regions, especially in the tropics and subtropics, may suffer significant adverse consequences for food security, even though the effects of climate change on global food production may prove small to moderate;
- there could be an increase in a wide range of human diseases, including mortality, and illness due to heat waves and extreme weather events, extensions in the potential transmission of vector-borne diseases, such as malaria, and regional declines in nutritional status;
- some countries will face threats to sustainable development from losses of human habitat due to sea-level rise, reductions in water quality and quantity, and disruptions from extreme events;
- technological advances have increased the range of adaptation and mitigation options, and offer exciting opportunities for reducing emissions, but are not currently available in all regions of the world.

This volume will be of great value to decision-makers, the scientific community and students.

The Intergovernmental Panel on Climate Change (IPCC) was set up jointly by the World Meteorological Organisation and the United Nations Environment Program to provide an authoritative international statement of scientific opinion on climate change. The IPCC prepared its first comprehensive assessment report in 1990, with subsequent supplementary reports in 1992 and 1994. *Climate Change 1995* is the first full sequel to the original assessment. Several hundred scientists and contributors, recognised internationally as experts in their fields, were brought together in three working groups to assess climate change for this Second Assessment Report. During drafting, the chapters were exposed to extensive review by many other independent experts, and subjected to full governmental reviews.

A List of Native Mammals of Wilsons Promontory National Park

Peter Menkhorst[1] and John Seebeck[1]

This list of native mammal species recorded from Wilsons Promontory National Park is derived principally from the Atlas of Victorian Wildlife, a database maintained by the Department of Natural Resources and Environment, Victoria, and which was used to prepare the distribution maps and species accounts in *Mammals of Victoria* (Menkhorst 1995). Much of the information concerning the native mammals of Wilsons Promontory was gathered during surveys carried out by the Department of Natural Resources and Environment (under earlier names) during the 1970s, but it has been enhanced by recent additions from incidental sightings and special surveys. The bat fauna is poorly documented and further survey is warranted. The list is arranged as follows: vernacular name; scientific name; year of most recent record in the Atlas; our subjective assessment of the animal's status at Wilsons Promontory and comments. Details of introduced mammals found at Wilsons Promontory are provided by Seebeck and Mansergh (1998).

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Species Vernacular name/ Scientific name	Most recent record	Status	Comments
MONOTREMATA			
Short-beaked Echidna *Tachyglossus aculeatus*	1998	Common	
Platypus *Ornithorhynchus anatinus*	ca 1940	Presence doubtful	Only records are literature reports
MARSUPIALIA			
Dasyuridae			
Agile Antechinus *Antechinus agilis*	1998	Common	Formerly Brown Antechinus *A. stuartii*
Swamp Antechinus *A. minimus*	1997	Locally common	Abundant on Great Glennie and Rabbit Islands; unconfirmed reports from Kanowna Island
Dusky Antechinus *A. swainsonii*	1996	Uncommon	
Spot-tailed Quoll *Dasyurus maculatus*		Presence unconfirmed	Literature records only
White-footed Dunnart *Sminthopsis leucopus*	1992	Uncommon	
Peramelidae			
Southern Brown Bandicoot *Isoodon obesulus*	1994	Uncommon	
Long-nosed Bandicoot *Perameles nasuta*	1997	Rare	
Phalangeridae			
Common Brushtail Possum *Trichosurus vulpecula*	1997	Locally common	
Mountain Brushtail Possum *T. caninus*	1974	Presence unconfirmed	Single sight record only
Pseudocheiridae			
Common Ringtail Possum *Pseudocheirus peregrinus*	1998	Common	

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Petauridae			
Sugar Glider *Petaurus breviceps*	1998	Rare	
Acrobatidae			
Feathertail Glider *Acrobates pygmaeus*	1986	Uncommon	
Burramyidae			
Eastern Pygmy-possum *Cercartetus nanus*	1996	Locally common	
Phascolarctidae			
Koala *Phascolarctos cinereus*	1995	Uncommon	Significant remnant population NOT derived from translocated stock
Vombatidae			
Common Wombat *Vombatus ursinus*	1998	Common	
Potoroidae			
Long-nosed Potoroo *Potorous tridactylus*	1998	Uncommon	
Macropodidae			
Eastern Grey Kangaroo *Macropus giganteus*	1998	Locally common	
Tasmanian Pademelon *Thylogale billardierii*	ca 1850	Extinct	Wholly extinct in Victoria
Black Wallaby *Wallabia bicolor*	1998	Common	
CHIROPTERA			
Molossidae			
White-striped Freetail Bat *Tadarida australis*	1998	Uncommon	
Vespertilionidae			
Chocolate Wattled Bat *Chalinolobus morio*	1997	Uncertain status	
Common Bent-wing Bat *Miniopteris schreibersii*	1971	Rare	Only a single record
Lesser Long-eared Bat *Nyctophilus geoffroyi*	1997	Common	
Gould's Long-eared Bat *N. gouldi*	1983	Uncertain status	
Large Forest Bat *Vespadelus darlingtoni*	1990	Uncertain status	
Southern Forest Bat *V. regulus*	1997	Uncertain status	
Little Forest Bat *V. vulturnus*	1997	Uncertain status	
RODENTIA			
Bush Rat *Rattus fuscipes*	1998	Common	Animals on Great Glennie Island very large
Swamp Rat *R. lutreolus*	1997	Locally common	
Water Rat *Hydromys chrysogaster*	1998	Rare	
Broad-toothed Rat *Mastacomys fuscus*	1990	Rare	
New Holland Mouse *Pseudomys novaehollandiae*	1996	Rare, but may be locally common	One of only four Victorian populations
CANIDAE			
Dingo *Canis latrans*		Probably extinct	Replaced by feral Dog, *Canis familiaris*
OTARIIDAE			
Australian Fur Seal *Arctocephalus pusillus*	1998	Common	One of four Victorian breeding colonies occurs on Kanowna Island
PHOCIDAE			
Leopard Seal *Hydrurga leptonyx*	1996	Rare visitor	

The following letter was received from a member, Nick Romanowski, in reponse to an article in *The Victorian Naturalist* **115** (2), 1998, 56-62 by Golam Kibria and co-authors. The paper reviewed the biology and aquaculture of Silver Perch *Bidyanus bidyanus.*
Golam Kibria's response follows Nick's letter.
The editorial policy of *The Victorian Naturalist* is to publish a wide-range of papers touching on all aspects of natural history. We are always interested to receive comments from members on the content of the journal. Editor

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Dear Editor

What is an article on aquaculture of Silver Perch *Bidyanus bidyanus* (Kibria *et al.* 1998) doing in *The Victorian Naturalist*? It could be justified if it really was a summary of the biology of this species, but like many aquaculture articles this one deals almost entirely with growth responses under highly unnatural conditions – from spawning induced by injection of hormones, to growth rates on artificial diets at stocking rates far in excess of anything ever recorded in the wild.

What little mention is made of natural history in the article does not even report earlier work accurately. For example, 'competition for food from introduced cyprinids, and predation by English Perch *Perca fluviatilis*, have *probably* [my italics] played a part in [Silver Perch] decline' (Cadwallader and Backhouse 1983) remains an unsubstantiated, though plausible, guess. However, this has been completely rephrased as 'its population has been greatly reduced due to competition from introduced cyprinids [and] predation by the English Perch'.

The suggestion that aquaculture might have a role to play in rehabilitation of this species is spurious. All domesticated animals change both genetically and behaviourally from wild populations, although such changes may not be obvious in the first few captive generations. In the case of Silver Perch, many captive populations are derived from the original aquaculture stocks developed in southern NSW around forty years ago (Lake 1967). These were bred from small initial populations collected from a relatively small part of the range of the species, ideal conditions for initiating genetic drift.

If overseas aquaculture stocks of long standing are any guide, Silver Perch will gradually change in appearance from wild fish, becoming fleshier and less active, among other changes. Compare the thick-bodied, almost scale-less Mirror Carp *Cyprinus carpio* to any wild fish of the same species for an example of changes under domestication in less than a century, for just one obvious example.

All documented captive breeding programs for fishes, whether aquaculture-oriented or not, have started from a very limited genetic base – often as few as a half-dozen adult fish (Romanowski 1996; Caughey *et al.* 1990). The stocks produced by such programs are already a long way from being representative of their species, and reintroducing their offspring into natural waters on a large scale will only dilute whatever variability still exists in wild populations. This can also be a way to release new disease strains such as the piscine tuberculosis now common in probably all captive-bred Australian and New Guinea Rainbowfishes (*Melanotaenia, Glossolepis* and *Chilatherina*) (Tappin 1998).

The most irritating aspect of the article in question is that it is not an unbiased appraisal of the future of Silver Perch in aquaculture at all, but a selective promotion of the species. A close look through the apparently exhaustive reference list shows that the authors have omitted any that don't support their contention that 'demand to cultivate the species is increasing both in Australia and in nearby Asia'. Silver Perch is certainly the best prospect available for Australian freshwaters, unless we are prepared to take the potentially disastrous risks with introduced fish that have already destroyed a variety of indigenous fisheries overseas.

However, I have long warned (Romanowski 1994) that Silver Perch would not be so readily accepted overseas as its promoters would have us believe. More recent information from Taiwan (Walker 1996) makes it plain that the Taiwanese have already rejected this as a quality fish, with production there falling

from a peak of 500 tonnes in 1994, to 100 tonnes in 1995. Prices of around $5 per kilogram at the time make it clear that this is regarded as a middle-quality fish only, and that acceptance was poor against the wide variety of comparably priced species already available there.

Other obvious biases in the article include a claim that Silver Perch 'represent the main endemic freshwater aquaculture industry in Australia'. With a peak production of around 50 tonnes for the entire country in 1994/1995 (Kibria *et al*., 1998), this seems insufficient to compete with the 300 plus tonnes of freshwater crayfish produced in Western Australia alone (O'Sullivan 1995) in approximately the same time span.

There have been some excellent articles on the biology of native fishes in *The Victorian Naturalist* over the years, and I would certainly like to see more of them. However, I don't feel that aquaculture adds anything of value to a natural history magazine. If the word 'Biology' had been taken out of the title 'Biology and Aquaculture of Silver Perch' it would have been a more accurate statement of what it was really about, and also made it clear where it really belongs – in an aquaculture magazine.

All the best
Nick Romanowski

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Dear Editor

Response to Nick Romanowski regarding our review paper ' Biology and aquaculture of Silver Perch – A review' (Kibria *et al*. 1998).

This is a review paper of an Australian native fish, Silver Perch *Bidyanus bidyanus* based on published information of the species. The paper reviewed 'biology and aquaculture of Silver Perch' in the context of its natural history, natural habitats, biology, natural food and feeding habits, aquaculture and pollution potential. The review could be of interest to a wide of range of readers from naturalists to conservationists, aquaculturists, biologists and environmentalists. This paper was refereed and the summary of referee's comments may reflect the intention of the review: 'the paper is a comprehensive review of the current status of Silver Perch in terms of its known biology, conservation status and aquaculture'. Regarding the comments of Nick Romanowski about the paper, we would like to submit the following:

1. Causes of decline: we have combined the three main reasons for the decline of the Silver Perch population: (a) competition for food from introduced cyprinids, (b) predation by the English Perch and (c) the construction of dams that has prevented upstream migration, affecting the reproductive success. However, the last and most important point, which is the main cause of decline of Silver Perch populations in the wild, has been omitted.

2. Rehabilitation through aquaculture is spurious?: This statement is incorrect. Fisheries and aquaculture are interrelated disciplines, and aquaculture has been practised world wide not only to increase fish production but also to enhance natural fisheries through stocking with fry and fingerlings into dams, reservoirs and open waters. Rowland (1995) suggested that the

stocking of hatchery reared fingerlings can significantly enhance Australian native fish stocks (including Silver Perch) in natural waters whose populations have declined due to modification of freshwater environments. To rehabilitate native fish, State Government hatcheries in NSW and Victoria annually produce fish for stocking public waterways for both recreation and conservation purposes (Gooley and Rowland 1993). Furthermore, to establish and maintain recreational fisheries, NSW fisheries have so far stocked 11 million Silver Perch, Golden Perch and Murray Cod fingerlings into impoundments since 1976 (Rowland 1995). Additionally, fingerlings of native endangered Trout Cod (*Maccullochella macquariensis*) and Eastern Freshwater Cod (*M. ikei*) produced from hatchery were also stocked into waters where they had become extinct (Rowland 1995). However, it was mentioned that aquaculture of Silver Perch is not a solution to rehabilitate the species. If aquaculture is not a solution, what are the solutions? Unfortunately there was no solution given in the letter. If there are no measures taken then the Silver Perch population will continue to decline in the wild and will soon reach the 'endangered' category from the present 'vulnerable' category.

Secondly, it is widely accepted that overexploited and depleted fisheries can be rehabilitated through programs of artificial breeding, rearing and restocking in natural habitats (New 1991; Casvas 1995; Gjedrem 1997). The captive breeding programs are useful in conservation of aquatic organisms, in particular commercial species, since artificial breeding creates the opportunity to preserve ova or embryos (cryopreservation) and the establishment of gene banks for future use. Therefore these programs can be the basis for maintaining biodiversity of aquatic organisms that are most threatened by the impact of human interventions (Pullin 1993; Purdom 1993). Furthermore, androgenesis techniques open the way for germ plasm maintenance and the conservation of endangered fish species (Thorgaard 1986; Thorgarrd *et al.* 1990). Aquaculture has brought hope for the restoration and conservation of endangered fish species in many countries, for example, Reeves Shad in China, and American Shad in USA, where induced breeding, and a program for the release of hatchery-produced larvae and juveniles has been carried out to supplement the stocks in rivers (Hanping 1996). Salmon larvae, fry, fingerlings, and smolts are stocked to restore populations destroyed by acid precipitation and hydro-electric facilities in Norway (Torrissen *et al.* 1995). To increase the marine resources in Japan, several millions of fry of Kuruma Shrimp *Penaeus japonicus* are released every year, whereas in the USA salmon enhancement programs have been based on hatchery production of juveniles (Pillay 1990). In short, aquaculture can play a significant role in conservation of aquatic biodiversity and genetic resources (Anon 1998a).

3. About 'initiating of genetic drift': The high costs of keeping aquatic organisms encourage farmers to use small broodstock populations which can lead to inbreeding and negative consequences for farmed or released stocks. This problem could arise due to lack of knowledge of the basic principles of the brood stock maintenance. However, the majority of aquatic species used in aquaculture today are little changed from their wild relatives with the possible exception of Common Carp and ornamental fish (Anon 1998b). Most hatchery populations of Rainbow Trout *Salmo gairdnerii* have approximately the same amount of genetic variation as natural populations (Allendorf and Utter 1979; Busack *et al.* 1979). Despite all, there has been considerable progress on fish genetics to tackle the inbreeding problem. Research done overseas suggests that by maintaining effective breeding numbers (N_e), it is possible to avoid inbreeding or genetic drift problems (Douglas 1992). For example, Ryman and Stahl (1980) suggested that N_e could be at least 60 whereas the Food and Agriculture Organisation of the United Nations (FAO) recommends that N_e be at least 50 for short term work and 500 for long term work (FAO/UNEP 1981). Allendorf and Ryman (1988) and Tave (1993) have given a specific N_e of fish to be stocked in rivers and lakes for fisheries management programs or ocean ranching. The following publications deal with N_e of different species: Common, Chinese and Indian Major Carp (Jhingram and Pullin

1988), *Tilapia* (Tave 1986; Smitherman and Tave 1987; 1988) and Brown Trout (Ryman and Stahl 1980).

4. About 'dilution of the wild population and disease concern': There has been much development in the field of fish genetics for sustainable aquaculture and fisheries production. Through selective breeding or genetic transformation (transgenic species) of fish and crustaceans, it has been possible to produce strain resistance to diseases and parasites (Gjedrem 1995; Bachere *et al.* 1997). Therefore genetic transformation or selective breeding is also a solution to eliminate the spread of diseases at regional or international levels (Bachere *et al.* 1997). Some selection experiments have shown genetic improvements for disease resistance against dropsy disease in Common Carp (Ilyassov 1987), furunculosis in brown trout (Cipriano and Heartwell 1986; Dunham 1987) and Brook Trout (Embody and Hayford 1925; Dunham 1987). Moreover, the creation of sterile transgenic aquaculture species will avoid any spreading of the strains in the natural environment (Bachere *et al.* 1997). Aquaculture creates the opportunity to produce triploids which are sterile fish that can be cultured on farms or used in natural resources management. This process is an excellent way to utilise even exotic fishes for fisheries management while minimising adverse environmental impacts (Tave 1993). Triploids have been an important fish for stocking public waterways in the USA. For example, Striped Bass is one of the premier sport and commercial species in the USA. Fishing pressures, pollution, and destruction of spawning grounds and nursery areas caused the dramatic depletion of many stocks of Striped Bass. Sterile Striped Bass (produced by crossing Striped Bass with White Bass) are being stocked in rivers and lakes around USA to help relieve the fishing pressure on Striped Bass and to help restore local fisheries, without adverse environmental consequences (Tave 1993). It has been reported recently that the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is researching on a transgenic technology to develop aquaculture species which will complete their life cycle only on the farm. If the cultured stock escaped into the wild, their larvae and juveniles from wild spawning would die. This technology will improve fish production and will not pollute wild stocks (Anon 1998c).

5. About 'most irritating aspect and selective promotion of the species': It appears from the above comment that we wrote the review to promote the species and perhaps we are running a fish selling business! This was further linked to an exhaustive reference list. Silver Perch is a well known endemic freshwater species with a high aquaculture potential and does not need any promotional drive, and this fact was also acknowledged in the letter 'Silver Perch is certainly the best prospect for aquaculture in Australia'. The impression was also expressed that we have omitted some references but the list of those references was not given. However, referees who reviewed the paper commented that 'it is clear that the authors have conducted an extensive literature review'.

6. About 'represent the main endemic freshwater aquaculture production': The first line of our paper clearly indicated that 'the Silver Perch *Bidyanus bidyanus* is the most important **fish** contributing to major endemic freshwater aquaculture production (see the first line of the abstract in our paper). Secondly, production has been compared with Silver Perch and other native fish, but not with crustaceans (see Table 2 in Kibria *et al.* 1998).

Table 1. Topics covered in Kibria *et al.* (1998) and number of references quoted.

Title	Number of references quoted
1. General biology of silver perch	
(a) history, natural habitats, status	10
(b) biological characteristics of silver perch	19
(c) natural food and feeding	7
	36
2. Environment	
(a) salinity tolerance and distribution in salt water	4
(b) pollution potential	3
	7
3. Aquaculture of silver perch	
(a) aquaculture of silver perch	15
(b) artificial breeding	3
(c) nutrition	10
(d) growth and production	10
	38

7. About 'taking out the word biology from the title': This paper was reviewed by referees, accepted by the editor and published and no suggestion was put to us to change the title. Table 1 gives a break down of the areas covered and the number of references quoted.

8. Conclusion

We hope from the above discussion, that it is clear that aquaculture has a significant role in natural stock enhancement, conservation of aquatic biodiversity and genetic resources, endangered species restoration, and aquatic resource management. Aquaculture is currently providing much needed support to recreational and commercial fishers. Our review on the 'biology and aquaculture of Silver Perch' dealt with a native species, a species which is vulnerable and is of interest to recreational and commercial fishers. The species is being stocked in Victoria's natural waterways with fingerlings produced from aquaculture in order to enhance the state's fisheries. Aquaculture is an infant industry in Australia and therefore much of its benefits may not be known.

The primary threats to fish species are mainly due to destruction of habitat essential for reproduction and recruitment and competition with introduced species. Genetic threats are lowest (Purdom 1993). We hope that research on fish genetics being carried out under different projects such as the International Network of Genetics in Aquaculture (INGA), Gene Banking and Conservation of Freshwater Fish Project (GBCFFP), Genetic Improvement of Farmed *Tilapia* (GIFT), and locally by CSIRO will bring some more fruitful results for conservation of aquatic organisms, and sustainable aquatic food production. It should be mentioned here that genetically modified organisms (GMO) from aquaculture or their release for aquaculture and fisheries enhancement cannot be predicted with certainty, and in aquaculture and fisheries development, as as in agriculture and forestry (Pullin 1994), some loss of biodiversity is unavoidable. Therefore, it is necessary to assess risk and weigh potential benefits against environmental costs. We do agree with Pullin (1994) who stated that where GMO's are already the basis of important aquaculture and enhanced fisheries with no evidence of their having caused significant environmental harm, then it would be reasonable to pursue further development of such aquaculture or fisheries. We believe in ecologically sustainable development (ESD) as set out in the National strategy for ESD (NSESD) (Deville *et al.* 1995) and the same view has been reflected in the conclusion of our review.

Thank you.
Sincerely yours,
Dr Golam Kibria

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Saving the Environment: What Will it Take?

by Ted Trainer

Publisher: *University of New South Wales Press, Sydney. Paperback, 64 pp.*
ISBN 0 86840 648 1. RRP $9.95

The environmental movement has been claimed to be the most significant social movement to have occurred internationally since the emergence of socialism. Ted Trainer argues that environmental policies in the 1990s are failing to deal with the underlying causes of environmental decline, and presents key arguments for limiting economic growth.

Most people, including those who staff the government and non-profit environmental agencies, such as the Australian Conservation Foundation, assume that we can solve the environmental problem by more recycling, greater energy efficiency, stricter anti-pollution legislation, more national parks and greener codes for building, planning and products. Trainer argues that this emphasis is distracting governments from the real social and cultural causes of environmental decline. We are over-producing and over-consuming, he argues, and solutions to the environmental problem will fail unless we recognise this fact.

A US study shows that the average person consumes 20 tonnes of new material every year. Trainer argues that our society is more than 'somewhat' unsustainable: *'it is far beyond the levels of resource consumption and environmental impact that could be sustained'.*

Dr Ted Trainer teaches at the School of Social Work at the University of New South Wales. He has published extensively on environmental issues, and his books include *The Conserver Society* and *Towards a Sustainable Economy.*

Daniel Ernest McInnes
1906–1998

It was with great sadness that we learned that Dan McInnes had died on 24 September 1998, just short of his 92nd birthday. It was also difficult to comprehend. Dan had been such an active member for so long that one could not believe that he would not be found, still busy, somewhere in the Club.

Dan McInnes was elected a member of the Club at the AGM on 7 June 1954 when the Microscopical Society of Victoria was incorporated with the Field Naturalists Club of Victoria. In 1957 he became a member of Council, and from 1958 to December 1995 Dan is listed, in one capacity or another, in *The Victorian Naturalist*. He was Vice-President 1958–1959, President 1959–1962, and Immediate Past President from 1962–1967. A break from official duties might have been expected, but in September 1967 the Treasurer resigned and, typically, Dan offered to carry on until a new Treasurer was appointed. At the AGM in 1968 Dan became Treasurer, and in effect held this position until 1980, although at intervals during this period the position was officially vacant. In the Annual Report 1979/80 the President, Dr Brian Smith, paid tribute to the retiring Treasurer for his untiring work for the Club: 'His advice on Club matters in general as well as his sound financial guidance has been of incalculable value to the Club.' When the appointment of a new Treasurer was announced six months later the Club Reporter commented 'Actually the Club has been without a Treasurer since the last Annual General Meeting but Mr McInnes (being Mr McInnes) has continued to see us through although officially he was merely a "bookkeeper"'. The Club was very dear to Dan's heart and he would not let it falter for want of a helping hand. From 1977–1983 he was Book Sales Officer, providing a much-appreciated service, as well as making a considerable profit for the Club, and he continued looking after the sale of back issues of *The Victorian Naturalist* stored in his old shop at 129 Waverley Road until 1995.

Dan may not have been in favour of the incorporation of the Microscopical Society with the Club, but from the outset he threw himself into the life of the FNCV. The Microscopical Group was formed immediately, Dan was the Excursion Leader, and the first excursion was to Albert Park Lake, one of his favourite hunting grounds. Pond life was his abiding interest, and many times members will have heard him say at a General Meeting that he had popped down to the lake for a jam jar full of water because he knew there was bound to be something of interest in it for him to exhibit under a microscope. Most likely nothing new to him, but it enabled him to pass on some item of knowledge to others, and that was equally important to him. He was never at a loss to find something to exhibit, and the breadth of his interests is revealed in the variety of specimens he displayed: the blood circulation of a tadpole;

a nautilus shell, the animal and its eggs, found at Middle Brighton; rock sections; the proboscis of a blowfly; fossil coral from Lilydale Quarry; rotifers; live cheese mites from matured cheese (probably found in his delicatessen stock); Wolffia and liverworts to name but a few. His exhibits were always accompanied by notes, and he would frequently draw members' attention to further information to be found in books in the library. In this connection it is interesting to read the report of the meeting of the Microscopical Group which was held in the Herbarium Hall in January 1955, when 'Mr D. McInnes stressed that all members attending a future meeting should bring a microscope, irrespective of whether they have a specimen or not at the time. A slide will be supplied, and if the member is diffident about making the few necessary remarks relevant to the slide, then arrangement will be made for a substitute to do this for him.' People were to be involved and encouraged, and one of the things that impressed Ray Power was Dan's 'ability to put on a talk at a moment's notice'.

Besides his involvement with the Microscopical Group, Dan was also a member of the Entomology and Marine Biology Group, the Geology Group, and in time, the Day Group. This latter was formed in 1972 to cater for leisured and retired members who did not want to attend meetings at night. Their inaugural excursion was to the Botanic Gardens. It was reported that 'Mr McInnes took us to see an unusual Chinese Oak tree.'

Although not a founder of the Hawthorn Junior Field Naturalists Club, Dan was closely connected with it for many years, and was President from April 1962, stepping in after the sudden death of their President, until August 1971. Many members, and future Office Bearers of the FNCV, had their interest in natural history fostered by Dan, and for one member at least there has been the recent joy of having her child inspired by Dan, as she was. In 1969 he was made a Life Member of the Hawthorn Junior FNC.

Dan was essentially a practical man, and nowhere is this revealed more clearly than in the construction of the FNCV microscope. In a series of articles in *The Victorian Naturalist* he outlined the problem with cheap commercial microscopes, which were unsatisfactory for both children and adults starting to use them, and explained his design which had been constructed by W.C. Woollard, an engineer and keen microscopist, who had developed the original idea into 'a really practical, first-class microscope'. So popular was this microscope, sold at a very reasonable price, that over 140 of them were made for members. Dan and W.C. Woollard both received Honorary memberships in May 1964 in recognition of this work.

One of the major Club events from very early days was the annual Nature Show, held in the Lower Melbourne Town Hall. During the 1960s and 1970s Dan was chairman of the Nature Show Committee, and Jim Willis, in his centenary history of the FNCV, described Dan's indefatigable leadership' in organising these Shows. Each one featured a particular theme. The Hawthorn Juniors played a significant part, and as an indication of the amount of work involved the report on the 1967 Show states 'D. McInnes and the Hawthorn Juniors are the proprietors of Instant Caves Ltd: the caves come in assorted sizes complete with stalactites and stalagmites. We understand that with modern methods the manufacturing time has been cut from several million years to 26 weeks.' In 1964 the Hawthorn Juniors mounted a 'realistic beach scene' and demonstrated making rock slides under the FNCV microscope. On another occasion a geological scale model of the Yarra Valley was constructed under Dan's guidance.

Dan wrote a number of articles for *The Victorian Naturalist*, and the one called *A Pond Hunter's Dream*, published in 1990, wonderfully transmits his abiding interest in pond life. He describes the pond hunter as 'that odd person who may be seen occasionally, dipping with his pond net into a lake' and says that 'pond hunters in their rambles always have that dream of the pond that has all the interesting forms of life they read about but never come across in their samples of pond life.' He goes on to describe such a dream pond. The article conveys the excitement of finding all sorts of fascinating life, and also contains much practical advice on equipment and methods. It is not written to show off some

obscure knowledge, but to make others aware of the subject, and to assist anyone to develop an interest of their own. An interesting article on *Wolffia australiana* was the result of his being asked whether he had ever seen this tiny duckweed in flower. He hadn't, so he investigated. Dan's keen interest and sharp eye finally led him to the discovery in 1983 of a species previously unrecorded for Australia, a foraminiferan, *Shepheardella taeniformis*, in material collected from Black Rock. Subsequent trips to Port Phillip Bay revealed more specimens, which led Dan to speculate that this foram was fairly plentiful; but it had taken his keen observation and wide knowledge to identify it.

The fact that Dan was never Club Librarian, nor Editor of *The Victorian Naturalist* did not mean that he had no involvement in these aspects of the Club. He was always willing to lend a hand in the library, he looked after the binding, and when the library went into storage he listed all the books kept out for use by the Microscopical Group. The geological map and reports collection also bears witness to his organisation. As time went on it became increasingly obvious that a supplement to the cumulative indexes to *The Victorian Naturalist*, which covered issues only to 1978, was necessary. Dan, embracing new technology, acquired his own computer, and in collaboration with Pat Grey, produced an index covering the next ten years.

When Dan became President in 1959 he introduced the idea of name cards for members at meetings. He wanted everyone to feel involved, and he saw it as part of his job to talk to people at General Meetings. A revealing item appeared in the report of the January meeting in 1960 when he appealed for people who arrived early to help set up tables, lights, microphone etc. so that he could have more time to greet and get to know members. This says as much about Dan's activities in the background as about his view of his responsibilities as President. He was always very generous with appreciation of other people's efforts. When in 1985 a presentation was made to Marie Allender 'For Outstanding Service' it was Dan who compiled a list of excursions Marie had arranged, and spoke of her record in this capacity and as a Councillor. I, too, have reason to be grateful to Dan. It was he who recommended to Council that as I had been Club Librarian for eleven years, as well as holding various other offices from time to time, I should receive an Honorary membership. That was when Dan was 90, and his interest in Club affairs was still as keen as ever. Delve into the Club's activities anywhere in the last 44 years, and you will almost certainly find Dan, contributing. He will be greatly missed.

Our sympathy goes to Chriss McInnes, herself a member for the last 40 years, and to the family.

Sheila Houghton
12 Scenic Court,
Gisborne, Victoria 3437.

I am indebted to Tom May
for assistance with this obituary.

(Photo of Dan taken at the FNCV Centenary Meeting, 5 May 1980)

Vale
Norman Stanford

We regret to announce the death of Norm Stanford on 26 November, 1998. Norm was elected to the Club in February 1983, and was Subscription Secretary from 1986 to 1988. Microscopy was his chief interest, and although he resigned from the Club when he and Helen moved from Melbourne, he continued to attend some meetings of the Microscopical Group as a member of an affiliated Club. Norm was re-elected to the FNCV in July 1997, and attended meetings until shortly before his death. Our condolences go to Helen Stanford, who was Book Sales Officer for several years.

Sheila Houghton

A Long Walk in the Australian Bush

William J. Lines

Publisher: *University of New South Wales Press Ltd., 1998. RRP $19.95.*

The vexed question of land utilisation in general and forestry in particular has exercised the mind of Bill Lines since he was a boy growing up at Gosnells, near Fremantle in Western Australia. His formative years are described in his publication 'Taming the Great South Land' (Allen & Unwin Ltd. 1991). As a boy he watched the sand track on which his parents lived become the Fremantle Road as bush was cleared, swamps drained and the land became yet another subdivision.

The work under review is concerned with a physical and philosophical journey along the Bibbulmun Walking Track, undertaken in the spring of 1993. The Bibbulmun Track commences at Kalamunda, only a few kilometres from Gosnells, in an area Lines has been familiar with all of his life. The track, covering a distance of 650 kilometres, followed mainly along old logging and fire roads, and the various sections provide the story of the forest during the past 170 years. The first logs were taken in 1829, when timber was required for repairing HMS *Sulphur*. The British Admiralty was so impressed with the work that 200 tons of timber were ordered in 1831, followed by further orders in 1837. Over the next few decades intermittent logging occurred, but began in earnest during the 1870s as the 'inexhaustible abundance' began to be exploited. Baron Ferdinand von Mueller visited the region on two occasions during this period and recommended that a bureaucratic structure be established to exercise surveillance, prevent waste and encourage the natural upgrowth of young trees.

As Lines and his companion travel along the track it is made abundantly clear that rather than exercising such care, much of the forest has been used rather as a quarry. That clearing for agriculture, some selective logging for timber, and a great deal of clear felling for wood-chipping for the Japanese market occurred becomes apparent as the walk progresses. Complete utilisation of the forest appears to be the aim of foresters and, in 1968, the then conservator of forests in Western Australia saw wood-chipping as the realisation of this dream. In addition, the damming of rivers and streams and their pollution by agricultural and industrial run-off have added to the destruction. As in so many other parts of the continent, salinisation has occurred on a large scale, particularly where the forest has been cleared for broad-acre farming.

Distinctions are made between natural calamities and those visited upon the forest by human interference. In particular, much reference is made to the differences in land utilisation by the original inhabitants and those who displaced them. The author is at pains to emphasise the importance of the forest for its own sake and not for utilitarian purposes, however laudable. He implores nature lovers to base their efforts at preservation on the fundamental ethic that plants and animals have a right to exist and to be left alone because they exist.

Although dealing with a relatively small part of the south west of Western Australia, a narrow belt of very distinctive land between Perth on the west coast and Walpole on the south coast, the implications of the story have universal application. As David Suzuki said in another place, 'we assault the planet as if it is limitless and endlessly self-renewing'. This emphasises the fact that the story Bill Lines tells is not unique to the south west, or even to Australia, but is being repeated over and over in different parts of the world.

The book, a paperback of about 200 pages, is recommended for the important observations made concerning the use and abuse of the planet. Although it makes no difference to the message that Lines is conveying, it is noted that the track that he and his companion walked is not now in use. A new, purpose built and recently completed

Bibbulmun Track, to the east of their route and mainly through conservation areas, is now the official route and extends the track a further 180 kilometres eastwards to Albany. It has numerous campsites, each about a day's walk apart and with conveniences to make the long walk more pleasureable. Whether it has the same impact is another story.

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George Caley, Nineteenth Century Naturalist

by Joan Webb

Publisher: *Surrey Beatty & Sons, 1995. 185 pp., many illustrations (black & white, colour). R.R.P $37.95.*

Not far from the Botanic Gardens in the Blue Mountains, NSW, a peak carries the name Mount Banks. It was given by an English botanist, George Caley, to commemorate Joseph Banks, for whom he collected many Australian plants early in the nineteenth century. Caley was explorer as well as botanist and is commemorated physiographically and botanically – mainly in NSW. Three peaks, one genus and several species of Australian plants still carry his name. Robert Brown, another of Banks' botanists, gave Caley's name to an orchid genus – *Caleana* – and described Caley as '*botanici periti et accurati*' – a skilful and accurate botanist. Non-Victorian species of *Banksia*, *Grevillea* and *Eucalyptus*, retain the specific name *caleyi*. Victoria's swamp violet, *Viola caleyana* G. Don, also commemorates Caley.

George Caley collected only very fleetingly on the coast of what would later become the colony of Victoria, but because his recent biography is of general botanical interest, I think it deserves mention in *The Victorian Naturalist*. My more detailed review is published in *Historical Records of Australian Science*, vol. 12, June 1998.

During Flinders' coastal survey of New Holland (1802-5), Brown collected thousands of plants for Banks and named many in his substantial *Prodromus Florae Novae Hollandiae et Insulae Van Dieman* (1810) and supplement – *Supplementum Primum Proteaceas Novas* (1830). Some he collected with Caley in the vicinity of Sydney and the Blue Mountains. Brown's influential role in Australian botany is widely recognised. But Caley, who collected in New Holland over a longer period of time and may have foot-slogged a greater total land distance, published nothing, and is relatively unknown.

Assisted by botanists and librarians, Joan Webb investigated herbarium specimens as well as correspondence, journals, maps and reports at the present herbarial home of Banks' and Brown's botanical collections – the Natural History Museum in London – and other European, American and Australian herbaria. In *George Caley, Nineteenth Century Naturalist*, the product of her extensive detective search for Caley, Webb discusses his Australian botanical work between April 1800 and May 1810, and the botanical consequences of that work.

In 1795, Caley wrote to the great botanist Banks to introduce himself and enquire about employment. Caley mentioned that he was born on a memorable day for Banks – in June 1770, when Captain Cook's *Endeavour* was almost wrecked on the Barrier Reef and Banks feared for the survival of the rich plant collection from the aptly named 'Botany Bay'. Later Caley accepted Banks' offer of employment and collected for him in New Holland. Of the relatively few Australian plants described by 1800, Caley had studied those cultivated in English gardens and described in

botanical publications.

Caley made three sea voyages from Sydney. One was an exploratory expedition in 1801 to survey Bass Strait and Western Port on the *Lady Nelson* under Lieutenant James Grant. Webb could find no Caley journal for this expedition, although he wrote to Banks that

> when I have nothing to do I shall write out my voyage to Western Port, but had it been more interesting I should have done so long ago.

Webb mentions that Caley found few plants he had not already seen, but not whether any of Caley's expedition specimens survive.

In 1805, Brown took his massive New Holland collection, including some Caley specimens, back to Banks and began documenting it. In his *Prodromus* Brown established many new genera, including two orchid genera, *Caleana* and *Pterostylis*, for which he named and described many species, including *Caleana major*, *Caleana minor* and about a dozen species of *Pterostylis*, which are now recognised as Victorian. Meanwhile, in the antipodes, Caley was using a taxonomic system being discarded by Brown and genera established before 1801. Caley was more than a mere collector and provided new specific names for genera he recognised and sometimes ventured to create new generic names. He had a substantial orchid collection and recognised that certain hooded orchids could not be accommodated in any established genus and deserved their own genus. Because they reminded him of the hooded Druids, he called the new genus *Druid's Cap*, which Brown latinized and used until he established the genus *Pterostylis*.

Caley provided specimens and names for other botanists to use. Some of Caley's many Australian specimens, especially in the Proteaceae and Orchidaceae, are type specimens for taxonomic names published by others, usually Robert Brown. Furthermore, some of the published names are Caley's manuscript names. Webb found evidence of the publication of eleven of Caley's manuscript names. Some are for species indigenous to Victoria, including four published in Brown's *Prodromus* – *Leucopogon juniperinus* R.Br., *Thelymitra pauciflora* R.Br., *Scutellaria mollis* R.Br. and *Xanthorrhoea minor* R.Br. – and one in his *Proteaceas Novas* – *Persoonia rigida* R.Br. On his herbarium label Brown wrote '*Persoonia rigida* Caley', but because he rather than Caley published that name, Brown's rather than Caley's name remains attached to that plant name.

Webb's book includes maps and illustrations including Bauer's exquisite depiction of *Caleana major*, which are clear and informative; there are useful appendices, including 'Plants named after Caley' and 'Caley's Eucalypts', and a good bibliography. Unfortunately, the index lacks taxonomic names – not even Brown's genus *Caleana*! I admire Webb's persistent detective effort in her search for clues about Caley and his collections and recommend *George Caley, Nineteenth Century Naturalist* to *Vic. Nat.* readers who share my interest in Australian botanical history.

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The Victorian Naturalist

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New Zealand Fungi: an illustrated guide
(Revised edition)

by Greta Stevenson

Publisher: *Canterbury University Press, 1994.*
Paperback, 126 pp., 15 colour illustrations. RRP $19.95.

These are indeed fortunate times for those field naturalists whose interests include fungi. The appearance over the past decade or so of several excellent mycological publications, as well as initiatives such as the Fungimap project, are indicative of a positive period in mycological research in Australasia. This review of Greta Stevenson's publication *New Zealand Fungi: an illustrated guide* is placed within this context.

First published in 1982, under the title *Field Guide to Fungi*, this book includes a table of contents that would have presumably been eagerly sought by field mycologists. The introduction and following chapter attempt to define fungi in terms of their position in a broad hierarchy, and by some explanation of fungal life cycles and reproduction. Information is provided on detrimental and beneficial roles of fungi, including the important concept of mycorrhizal associations.

Two very brief chapters on finding and collecting fungi are followed by a more detailed series of chapters dealing with the recording of information, and preservation of collected specimens. These chapters utilise illustrations of both macroscopic and microscopic detail, as well as providing a scheme for compiling notes on specimens.

After a skeletal explanation of the process of nomenclature, a brief description of the four classes to be dealt with, and a blunt explanation of the author's choice of classification, there is a hiatus created by the insertion of a short chapter on reference literature plus a bibliography.

The remaining one hundred pages of the book contain descriptions of taxa from only two of the classes mentioned above. This section includes a key to some genera of the *Agaricales* (with a table-format guide to genera of gilled fungi), a key to orders of the Gasteromycetes, as well as a few illustrations and the 15 coloured plates. The book concludes with a reasonable glossary and index.

The overview provided above presents a book that seems to contain most of the topics sought after in a publication of this type. A more critical look, however, reveals several features of considerable concern.

The publisher's note at the opening of the book acknowledges that a number of fungi have undergone taxonomic revision since the first edition in 1982. There seems to have been no attempt to accommodate these changes in the revised edition of 1994. In fact, no editorial changes seem to have been made at all in the revised edition. This may be a result of adhering to Stevenson's conservative line of classification, expressed in Chapter 9. Although some explanation of the author's choice of classification is welcomed, the divisive discussion dealing with this issue could well have been expressed through a more appropriate forum.

The use of a wide left margin to comment on points of classification, and for specific referencing, is to be commended. However, the overall referencing style lacks consistency and informative detail.

A lack of attention to grammar and sentence structure is reflected in a somewhat clumsy style of writing, and results in a loss of clarity in the text. This lack of attention to editorial detail is also exemplified in the entry for *Gomphus*, where Stevenson acknowledges that 'two new species have been described recently by Dr Barbara Segedin in Auckland Fig. 14.1'. No reference is given as to where to find these descriptions; no illustration of *Gomphus* appears in Fig. 14.1, which illustrates *Podoserpula pusio*, *Schizophyllum commune*, *Stereum hirsutum* and *S. pur-*

pureum; and both *Podoserpula* and *Schizophyllum* are misspelt!

The colour plates are a welcome addition to the revised edition and, although half of those presented are very small, the quality allows recognition of the main diagnostic features. Once again, however, the editorial standard could be improved. The colour plate of *Morchella conica* is not supported by a description in the text, and does not appear in the index.

A redeeming feature of this publication is the numerous descriptions of both genera and species. It is unfortunate that here too there are issues of concern. For the large and important genus *Cortinarius*, it is acknowledged by Stevenson that 'the majority of species are mycorrhizal and seem to be specific to one species of tree', and 'in the *Nothofagus* forests they abound', and yet no species of *Cortinarius* gets a mention anywhere in the book. A coloured plate depicting an unidentified species of *Cortinarius* was selected to represent the genus.

To conclude, expectations of an improvement in quality in the revised edition of this book have certainly not been fulfilled. If a reliable, modern field guide is what you're looking for, *New Zealand Fungi: an illustrated guide* is regrettably a publication that should be overlooked by discerning field naturalists in Australasia.

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Some Records of the Fungus Blackfellows' Bread *Polyporus mylittae*

Travelling along the Grand Ridge Road through the Eastern Strzeleckis in May 1970, I stopped to take a look at a freshly-cleared area, clear-felled, behind the cathedral arches of the tall Mountain Ash that fringed the roadside. It was a scene of desolation, the southern hill slope was devastated save for a small group of enormous old trees that the bulldozer wouldn't tackle. They stood forlornly open to the four winds. The good earth had been torn to pieces, bashed and pounded and left in deep holes and humps. There had been some rain since the felling, and on any bruised but unbroken stretch of this moonscape a crop of big white mushrooms, each one solitary, gilled and tough, had appeared. I knew them for the fruiting bodies of Blackfellows' Bread and a little delving in the soil confirmed this. Evidently the disturbance of the soil, or the removal of the overhead cover, combined with the overnight rain had induced all this fungus to fruit.

On a long-cleared and grassed-down farm at Nerrena, in the autumn of 1968 the farmer began to cultivate a paddock that had not been broken for a generation. The plough turned up dozens of large sclerotia, many in the soft, fresh stage when they resemble coarse sponge or honeycomb. In the hard stage this polypore is shiny and hard like a lump of horn. In another instance, a nurseryman at Leongatha North moved onto a bush block and began to clear an area for an orchard. He too turned up many big hard sclerotia which makes me think that in our high rainfall part of Victoria at least, this fungus must be quite plentiful under forested or long-untilled earth. It would not be noticed unless it fruited.

Questioning the edibility of this fungus I once asked an Aboriginal man from the Western District if the native peoples really had used it as a food item. His reply, 'My word yes! When we could get it fresh', makes me wish to try it myself.

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The *Cordyceps* Update

Well, another Cordy season is just about over – and just as well, too, seeing as how I've foolishly become a student again and this year's 'peak' coincided nicely with semester one's assignments! I keep thinking 'this year there won't be many – surely they've wiped out the caterpillars by now'. And each year, for the last five years, up they've come!

For those rapidly reaching the conclusion that we have here a raving lunatic, you are most probably right, but what I'm raving about is the common vegetable caterpillar fungus, *Cordyceps gunnii* (Figs. 1, 2).

Cordyceps is a genus of some 300 species, the large majority of which are predators of various arthropods, mostly insects, during the 'sexual' phase of their life cycle. They are represented worldwide in temperate and particularly tropical environments, with several species known in Victoria, of which *C. gunnii* is probably the most common. I was delighted to see the inclusion of this and *C. hawkesii* as target species in the updated fungimap project. My observations and records suggest this species will be found over a wide range of habitats, usually in the 'wet' season. At my place, outside Healesville, they are in evidence from March to July (sometimes a bit earlier and/or later), although no individual specimen lives that long.

You will remember that I described these bizarre organisms as predators, rather than as parasites, their usual description. Consider the probable lifecycle of *C. gunnii*. Their spores in the soil encounter the cuticle of either one species or a few related species of ground living 'goat-moth' caterpillars (family Hepialidae). They 'recognise' this as a place to grow, and germinate, producing an array of enzymes and using mechanical action to penetrate into the larval haemocoel (the sloppy insides of an insect). If successful, the fungus then reproduces asexually, attempting to avoid the insects' fairly primitive immune response. There may or may not be a 'wait period' involved here, depending on exactly when the caterpillars are first penetrated. The fungus only appears to be active in 'full-sized' caterpillars, but I have no idea as to whether they are only attacked late in their life cycle (perhaps as they prepare their burrows for pupation and eventual exit), or earlier. The latter seems to imply a wait and also a trigger to activate the fungus, which could be the hormonal surges associated with pupation. The fungal mass eventually completely fills the haemocoel – in effect, the entire body of the caterpillar is consumed and becomes fungus (Fig. 3). Most other species of *Cordyceps* also consume the body of their victim in this manner. Thus, I suggest that these organisms be more correctly classified as predators.

Beginning late summer-early autumn, the fungus begins growing upwards through the caterpillars tunnel. They usually begin to appear above ground in numbers after the first good rains, but some appear, albeit usually small, even in drought conditions. There is a surprisingly large variation in both the life span and size of the fertile stroma – the dark olive to black, finger to

Fig. 1. *Cordyceps gunnii* Healesville, 1995. The specimen is approximately 60 mm high and 10 mm in diameter.

Fig. 2. *Cordyceps gunnii* Healesville, 1996. A 'double-header'.

Fig. 3. *Cordyceps gunnii* Healesville, 1996. The 'double-header' exhumed, clearly showing the caterpillar's remains.

club shaped part of the fungus we actually see. Some last for only a week or two, others for several months. Some may reach 15 mm, others 150 mm, though most are around 50 mm high by 10–15 mm wide, and are generally smaller when it is drier.

Unlike some of the other local species, for example *C. robertsii* and *C. taylori*, that produce stroma for several years from the same caterpillar, *C. gunnii* converts the caterpillar to as many spores as possible within a single season, probably using one of several strategies. These range from the tortoise – long life, slow spore production, to the hare – short life, fast spore production. After a period of fine weather, some specimens can be found with a cotton wool covering of millions of spores, which will all be 'gone' after the first rain – into the soil, to await the arrival of the next generation of unfortunate insects. For the past five years, roughly half the caterpillars in my study area have become such unfortunates.

Sometimes more than one stroma can be observed growing from a single caterpillar. Fungi can have some complex mating systems, and it may be that such 'multiple-headers' represent the end result of incompatible mating types 'fighting' for their share of the caterpillar – intraspecific competition at very close quarters! Some preliminary DNA analyses were 'suggestive', but unfortunately my technique did not prove equal to a final resolution at that time. I hope to complete this study with a specialist in this area at a future date.

All parts of the fungus except the fertile layer of the stroma are eventually attacked by the larvae of fungus gnats and an assortment of other tiny arthropods. The stroma may break off the stipe, or be scratched out by an assortment of mammals and birds. The fertile layer will keep producing spores regardless, until it has exhausted its food supply, or becomes food itself for other fungi. The soil around here must be saturated with spores – it's amazing any caterpillars escape!

Entomopathogenic fungi have not been seriously investigated in mainland Australia. Nor have there been many long-term ecological or population studies of any fungi. The same can be said for a number of other phyla, let alone genera and species. It took me a long time to realise that a good place to look was in your own yard and I'm not even going to be able to work out the entire life cycle of just this one fungus. There's plenty to do!

Cheers, Rod.

P.S. I've accumulated a fair amount of literature on entomopathogenic fungi, particularly *Cordyceps*, and may be able to help others in this area. The best publication in English is Samson, Robert A., Evans, Harry C. and Latge, J. P., *Atlas of entomopathogenic fungi*, Berlin: Springer-Verlag, 1988.

Glossary

entomopathogenic – organisms that cause disease in insects; in this case, fungi but they are also attacked by bacteria and viruses.

haemocoel – fluid-filled body cavity of an insect.

stroma – the fertile or spore-producing part of a fungus, usually a 'mushroom' or 'toadstool', in this case a 'club'.

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Emperor: the Magnificent Penguin

by Pauline Reilly

Publisher: *Kangaroo Press (Simon & Schuster), Sydney 1998*
32 pp, paperback, RRP $9.95

'This is a story of outstanding endurance in the coldest, windiest, driest place in the world.' So begins Pauline Reilly's book 'Emperor: the Magnificent Penguin', an account of the lives of Emperor Penguins *Aptenodytes forsteri* in Antarctica. Living and breeding in these conditions, Emperor Penguins appear to have a woeful existence until one becomes aware of some of the adaptations acquired through 55 million years of evolution (the estimated age of the earliest fossil penguin). Emperor penguins standing on ice with young sitting on their feet are one of the most durable of Antarctic images and indicative of the sorts of intriguing physiological and behavioural adaptations to environmental extremes which are a part of Emperor Penguins' lives. At first glance much of what these birds are capable of doing appears to be more science fiction than fact. They can fast for five months, dive to depths of 400 metres, survive temperatures of minus sixty degrees Centigrade, raise young in the darkness of the Antarctic winter and travel up to 200 kilometres across ice to their breeding colonies. The author weaves these feats into the annual cycle of 'Emperor', the focal male of this account as he and his mate successfully rear an offspring. The acknowledgement of Drs Barbara Wienecke and Roger Kirkwood in the text (two of the world's leading authorities on this species) is testimony to the factual authenticity of the account.

The book is well written in a style aimed at a wide section of the community with a benign level of information and complexity. There are colour photographs on every page and these provide a spectacular complement to the narrative. Some of the photographs are particularly compelling; 'Moonlight in winter' (by D. Murphy), 'A small huddle', and 'A thriving colony' the centrepiece (by G. Robertson) and another, erroneously captioned, 'Moonlight in winter' (by R. Kirkwood) beautifully depict aspects of the lives and habitats of the penguins. The map of Antarctica on page six is not particularly useful and is, in my opinion, a missed opportunity to give some indication of where 'Emperor' breeds and feeds. It would also have been helpful to include a map of known breeding colonies and perhaps plots of where individual penguins have been tracked by satellites on their foraging trips.

The author of this book is an interesting story in herself and well-qualified to write about penguins. Born in Adelaide, she worked as a secretary until the outbreak of World War II and then as a censor before going to Army intelligence and finally in anti-aircraft duties. After raising a family she commenced ornithological studies and, over a 40 year period, has achieved an impressive list of honours and publications. She was the first female President and first female elected fellow of the Royal Australasian Ornithologists Union (now Birds Australia), has been to Macquarie Island twice and carried out research studies of both Little *Eudyptula minor* and Gentoo *Pygoscelis papua* Penguins. Her study of Little Penguins on Phillip Island began in 1968 and continues today under the co-ordination of the Penguin Study Group. It has become one of the longest running studies of a bird in Australia.

I think 'Emperor: the Magnificent Penguin' will open the eyes of many people to this beautiful bird and its remarkable adaptations at a time when its future may be determined by processes resulting from our activities such as global warming and the exploitation of marine resources. It is an interesting and attractive production that should appeal to readers of all ages and interests.

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Index to Volume 115, 1998 is in the centre of this issue

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Cover: Miss Jean Galbraith (1906-1999), in later years. Jean's book, *Garden in a Valley*, republished in 1985, is on her lap. (See Tribute on page 73.) Photo kindly supplied by Ian Hyndman, Beechworth.

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Patchiness of a Floral Resource: Flowering of Red Ironbark *Eucalyptus tricarpa* in a Box and Ironbark Forest

Jenny Wilson[1] and Andrew F. Bennett[1]

Abstract

Red Ironbark *Eucalyptus tricarpa* is considered an important winter food resource for nectar-feeding birds which are a characteristic component of the fauna of Box and Ironbark forests. However, little is known of the flowering patterns of eucalypts within these forests. This study describes a 'snapshot' survey of flowering of Red Ironbark in a Box and Ironbark forest at a single point in time during the peak annual flowering period for this species. The flowering status of trees was assessed across several spatial scales; including individual trees (of different size classes), forest stands and geographic areas within the Rushworth, Redcastle and Costerfield State Forests, Victoria. Flowering showed high levels of heterogeneity, or patchiness, at each level and was recorded in only three of five geographic areas. In these areas, the percentage of trees observed flowering along transects ranged from 0-42%. There was a significant difference between size classes of trees, with more larger trees flowering than smaller trees. Flowering occurred in a greater proportion of trees with access to free-water (within 5 metres of a dam edge) than for those trees without access to free-water. In most box and ironbark forests, large, old trees have been replaced with many, relatively densely-packed, smaller trees and this shift in age structure, along with the apparent patchiness of flowering in these forests, may have important implications for the movements and ecology of nectar-feeding animals. (*The Victorian Naturalist* **116** (2), 1999, 48-53).

Introduction

Despite the dominance of eucalypts in the Australian environment, and the importance of many eucalypt species to nectar-feeding animals, relatively little is known of the flowering patterns of species within this genus. Our current knowledge of the reproductive biology and ecology of *Eucalyptus* spp. is based on a small number of species (House 1997). Studies of the flowering patterns and floral morphology of eucalypts have largely been confined to species used for timber, such as Mountain Ash *E. regnans* (e.g. Ashton 1975; Griffin 1980), and, occasionally, rare species have been studied (e.g. Fripp 1982; Sampson *et al.* 1989).

Nectar-feeding birds are thought to be important pollinators of many *Eucalyptus* species, and in turn, the trees provide nectar for birds (Paton and Ford 1977; Ford *et al.* 1979; Hopper and Burbidge 1982). Flowering also attracts invertebrates, providing a secondary source of food. The distribution of nectar-feeding birds is often patchy, and their abundance within an area may change greatly through time (e.g. Keast 1968; MacNally and McGoldrick 1997). There is some contention concerning the extent to which the distribution of nectar-feeding birds results from their movements to track floral resources, or whether other factors contribute to the observed distributions (Ford 1979; Collins and Briffa 1982; Paton 1985; MacNally and McGoldrick 1997; *cf.* Pyke 1983). A better understanding of the ways in which nectar-feeding birds respond to the distribution of resources may come from a better understanding of spatial variation in flowering patterns.

The distribution of box and ironbark forests is defined by altitude, geology and climate (Muir *et al.* 1995; Environment Conservation Council 1997). In Victoria, these dry forests and woodlands encompass the inland hills of the Great Dividing Range and the Northern Plains (Environment Conservation Council 1997). Here we refer primarily to forests on the inland hills of the Great Dividing Range. These forests have undergone major changes due to clearing, logging and mining, resulting in a fragmented forest system that now covers approximately 15% of its former area (Robinson 1993). Exploitation of natural resources over many years, such as logging for fence posts and firewood, has lead to a change of age structure within these forests in that older, large, widely-spaced trees have been replaced by younger and relatively dense stands of smaller trees (Newman 1961; Environment Conservation Council 1997). Several authors have speculated that large trees may be a particularly important source of nectar for birds (Traill 1995; Webster and Menkhorst 1992). However, the relationship between tree size and flowering has not been quantified for

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eucalypts in these forests.

Muir *et al.* (1995) record 29 species of *Eucalyptus* in box and ironbark forests of the inland hills in Victoria, with Red Ironbark *E. tricarpa,* Mugga Ironbark *E. sideroxylon,* Grey Box *E. microcarpa,* Yellow Gum *E. leucoxylon* and Red Box *E. polyanthemos* being dominant. The Ironbarks *E. tricarpa* and *E. sideroxylon* (previously subspecies) are geographically separated with *E. tricarpa* occurring in central Victoria while *E. sideroxylon* occurs mostly in inland New South Wales (Costermans 1994). The diversity of eucalypt species within these forests is believed to be important in providing a year-round source of nectar for a suite of nectar-feeding birds, some of which are resident, some nomadic, and others migratory (Environment Conservation Council 1997). Common nectar-feeding birds in these forests include the Fuscous Honeyeater *Lichenostomus fuscus*, Yellow-tufted Honeyeater *L. melanops*, Black-chinned Honeyeater *Melithreptus gularis*, Musk Lorikeet *Glossopsitta concinna*, Little Lorikeet *G. pusilla*, Purple-crowned Lorikeet *G. porphyrocephala*, Red Wattlebird *Anthochaera carunculata* and Noisy Friarbird *Philemon corniculatus*. At times, these species may occur in dense aggregations when trees are flowering heavily. *E. tricarpa*, in particular, is an important winter food source for many birds (MacNally and MacGoldrick 1997). This includes threatened species such as the Swift Parrot *Lathamus discolor*, which arrives from Tasmania to overwinter in these forests.

This study describes a 'snapshot' survey of flowering of *E. tricarpa* in a Box and Ironbark forest in July 1997, during a peak flowering period for this species (Goodman 1973). The aim was to provide an initial description of the extent of spatial variation in flowering of *E. tricarpa* trees in a forest by sampling across several spatial scales: individual trees (including different size-classes of trees), forest stands, and geographic areas within a forest block. The survey also examined whether trees with ready access to water flower more intensely and in greater frequency than those with limited access to water.

Study Area

Rushworth, Redcastle and Costerfield State Forests are a contiguous area of box and ironbark forest in central Victoria, covering approximately 25,000 hectares, in an area between the towns of Rushworth, Heathcote and Nagambie (here, 'Rushworth Forest' is used to jointly refer to these three State Forests). These forests lie between latitudes 37°35' to 37°52'S and 144°45' to 145°10'E. Rushworth Forest, like much of the box and ironbark ecosystem, is characterised by open-forest on soils which have low fertility and poor water holding capacity (Environment Conservation Council 1997) with a mean annual rainfall of around 430 mm in the north to 560 mm in the south of the forest (Land Conservation Council 1978). *Eucalyptus tricarpa* and *E. microcarpa* dominate much of the forest, over an open shrubby understorey, generally including Golden Wattle *Acacia pycnantha*, Twiggy Bush-pea *Pultenaea largiflorens*, and Shiny Everlasting *Bracteantha viscosum* (Muir *et al.* 1995). The ground layer is sparse, with common species including Black-anther Flax-lily *Dianella revoluta*, Bristly Wallaby-grass *Danthonia setacea*, and Spiky Guinea-flower *Hibbertia exutacies* (Muir *et al.* 1995). The forest is managed primarily for the production of firewood, railway sleepers and fence posts, but also for honey production, gold mining and the production of eucalyptus oil. Around 10% of the forest is managed as historic or conservation reserves (Environment Conservation Council 1997).

Methods

The survey was carried out in July 1997, at the apparent peak flowering time of *E. tricarpa* in Rushworth Forest. The forest was divided into five areas of approximately equal size (about 5000 ha); 'north', north-east', 'central', 'south' and 'south west'. In each area, stands of trees dominated by *E. tricarpa* were mapped by driving along major roads and within these mapped areas, starting points of 25 transects (5 in each geographic area) were randomly selected. From each starting point a 400 m transect was surveyed by walking along a compass bearing approximately perpendicular to the road and the size class and flowering intensity of all *E. tricarpa* trees within 5 m on either side of the transect line were recorded. Due to the random nature of selecting the transects, there may have been greater distances between transects within geographic areas than

between 'edge' transects in adjacent geographic areas.

Size classes of trees were based on the diameter at breast height (DBH) as follows: very small, 5 to <20 cm; small, 20 – <40 cm; medium, 40 – <60 cm; large 60 + cm. Flowering intensity was estimated on the basis of the area of foliage covered by fresh flowers (staminodes bright and 'fluffy'). The categories were:

0 no flowers,
0.5 1 flower to 5% foliage cover,
1 5 –10%,
2 10 – 20%,
3 20 – 30%,
4 30 – 40%,
5 40 – 50%,
6 50 – 60%.

In addition, the size class and flowering intensity for every *E. tricarpa* tree within 5 metres of the edge of a dam were recorded for two dams within each geographic area. These dams were selected opportunistically.

Results

Individual trees

A total of 2040 *E. tricarpa* trees was recorded from the 25 transects surveyed in Rushworth Forest (Table 1). Over 90% of trees were less than 40 cm DBH, while the overall average tree density was 204 stems/ha.

Across all transects in the forest, 6.7% (137/2040) of *E. tricarpa* trees were flowering. Fig. 1 shows the percentage of trees in each size class that were flowering compared with the percentage of trees present in all transects. There was a highly significant difference between size classes, whereby a greater proportion of larger trees were flowering than smaller trees ($\chi^2 = 48.75$, df = 3, $p < 0.0005$). However, for those trees that were flowering, there was no significant difference in flowering intensity between size classes (ANOVA $F = 2.67$, df = 3, $p = 0.29$).

Transects

Of the twenty five transects, 13 contained trees that were flowering while 12 had no trees flowering. In those transects with flowering, the percentage of trees flowering ranged from 1.2% – 42.2% (Fig. 2) and in each geographic area in which flowering was recorded, there was a significant difference between transects in the proportions of trees flowering (χ^2 tests, df = 4, $p < .001$).

Geographic areas within the forest

Trees were recorded flowering only in the 'north', 'north-east' and 'central' areas within Rushworth Forest. When all five areas were compared there was a significant difference in the overall proportions of trees flowering in each area ($\chi^2 = 99.8$, df = 4, $p < 0.0005$) but when comparing only the three geographic areas where flowering was recorded the proportions did not differ ($\chi^2 = 3.34$, df = 2, $p > 0.15$).

Trees associated with dams

One hundred and thirty six *E. tricarpa* trees growing within 5 metres of a dam edge were sampled and, of these, 59% (81/137) were flowering. This was a sig-

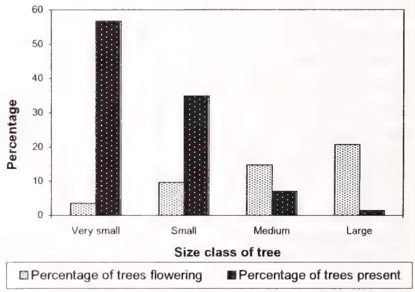

Fig. 1. The percentage of *E. tricarpa* trees in each size class that were flowering compared with the percentage of trees recorded for all transects over Rushworth Forest.

Table 1. The number and percentage of *E. tricarpa* trees in each size class for five geographic areas in Rushworth Forest.

Geographic area	Very small <20 cm		Small >20 – 40 cm		Medium >40 – 60 cm		Large 60+ cm		Total	
	n	%	n	%	n	%	n	%	n	%
North	199	*50*	156	*40*	31	*8*	7	*2*	393	19.2
North-east	263	*60*	142	*33*	28	*6*	3	*1*	436	21.4
Central	219	*53*	161	*39*	29	*7*	3	*1*	412	20.2
South	292	*61*	129	*27*	43	*9*	15	*3*	479	23.5
South-west	184	*58*	123	*38*	12	*3.7*	1	*0.3*	320	15.7
Total	**1157**	***(57)***	**711**	**(35)**	**143**	**(7)**	**29**	**(1)**	**2040**	***100***

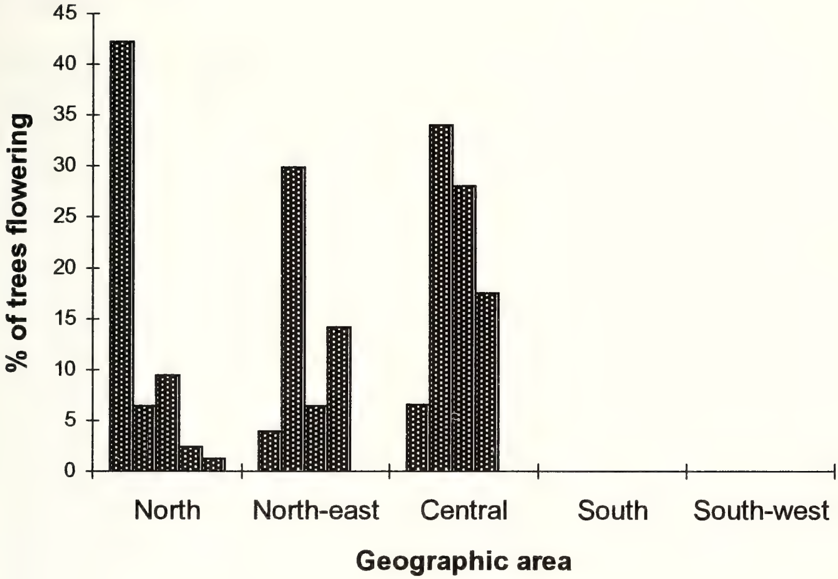

Fig. 2. The percentage of *E. tricarpa* trees in each transect that were flowering in each geographic area within Rushworth Forest.

Table 2. The number of trees and the percentage of *E. tricarpa* trees recorded flowering within 5 m of a dam edge, and from forest transects, for each of five geographic areas within Rushworth Forest. Key: No., total number of trees; %, percentage of trees flowering.

Area	Dams		Transects	
	No.	%	No.	%
North	64	62.5	393	10.9
North East	21	61.9	436	9.2
Central	20	52.3	412	13.1
South	20	40.0	479	0
South West	11	0	320	0

nificantly greater proportion than for trees sampled along forest transects ($\chi^2 = 360$, df = 1, $p < 0.0005$). In each area a greater proportion of trees around dams were flowering than trees on transects (Table 2). In the 'south-west', no flowering was recorded for trees on transects or at dams, while in the 'south' no trees on transects were recorded flowering, but one dam had trees flowering nearby.

When a comparison was made between the size classes of trees on dam edges and those on transects, a significant difference was evident ($\chi^2 = 39.8$, df = 3, $p < 0.0005$), with fewer 'very small' trees and more larger trees associated with dams. However, when flowering was compared for trees of the same size class, the proportion of trees flowering was greater for trees associated with dams than for those sampled along forest transects ($\chi^2 = 413.5$, df = 1, $p < 0.0005$) (Table 3). The mean flowering intensity for flowering trees associated with dams and forest transects did not differ (t-test $p = 0.74$) (Table 3).

Discussion

This survey has revealed marked spatial variation, or patchiness, in the flowering of *E. tricarpa* in Rushworth Forest in central Victoria. During the peak flowering period for this species in 1997, flowering was widespread in three geographic areas in the northern parts of the forest but was not recorded in two areas in the south. In the areas where flowering was recorded, there was marked variation in the percentage of trees flowering along each transect, ranging from 0-42% of trees per transect. Finally, at the level of individual trees, there was significant variation between size classes of trees in the proportion that were flowering, with greater likelihood of flowering for larger trees (Fig. 1).

Table 3. Comparisons between *E. tricarpa* trees within 5m of a dam edge and trees on transects in Rushworth Forest in relation to numbers of trees, size class distributions, percentage of trees flowering and mean flower cover of flowering trees.

Tree Size Class (DBH cm)	Number of trees		Percentage of trees in each size class:		Percentage of trees flowering		Mean flower cover (± 1 S.E.)	
	Dams	*Forest*	*Dams*	*Forest*	*Dams*	*Forest*	*Dams*	*Forest*
Very small (5 – <20)	46	1157	33.8	56.7	58.7	3.5	0.7 (0.1)	0.7 (0.1)
Small (20 – <40)	57	711	41.9	34.9	49.1	9.7	0.9 (0.1)	0.9 (0.1)
Medium (40 – < 60)	27	143	19.8	7.0	74.1	14.7	1.0 (0.2)	1.05 (0.1)
Large (60+)	6	29	4.4	1.4	100	20.7	1.0 (0.5)	1.0 (0.2)

Is a snapshot survey such as this study representative of the overall flowering pattern of a tree species? Could the absence of flowering be an artifact of a single sample in time, with flowering of certain trees occurring either later or earlier than the survey? Other evidence from the study area suggests that the patchiness shown in this snapshot survey is not an artifact but is typical of the flowering of this species. Regular monitoring of flowering at a number of other forest stands in the southern section of the forests showed an almost total absence of flowering of *E. tricarpa* throughout 1997 (J. Wilson, A. Bennett, *unpubl.*). Similarly, ongoing monitoring of the flowering of individual trees in this forest (J. Wilson, *unpubl.*) has also revealed significant differences in flowering in relation to tree size.

Variation in flowering between size classes of trees adds support to previous contentions that large trees are particularly important as sources of nectar for nectar-feeding birds (e.g. Webster and Menkhorst 1992; Traill 1995). Two factors appear to contribute to the importance of large trees. First, because a significantly greater proportion of large trees flower than small trees (Fig. 1), forest stands with large trees are likely to be a more reliable source of nectar from year to year. Second, although no significant difference in intensity of flowering was evident (measured as % foliage cover), large trees have a greater area of canopy foliage than smaller trees and will, for the same flowering intensity, support a larger number of flowers per tree. For example, Ashton (1975) reported that mature *E. regnan* trees produced between 1.6-15.5 times as many flowers as small trees ('pole' and 'spar' stages).

A significant difference between trees close to dams and those along forest transects in the proportion of trees flowering (Table 3) suggests that availability of moisture may be an important influence on the initiation of flowering for this species. Water deficits can cause inhibited growth at all stages of tree reproduction (Kozlowski 1982). Better knowledge of the factors that determine the initiation, timing and frequency of tree flowering is central to developing an understanding of the potential availability of nectar resources for birds in these forests. It is likely that flowering is influenced by genetic attributes and also by environmental features such as soil types, access to moisture, tree health and conditions in previous years (Florence 1964; Ashton 1975; Bolotin 1975; Porter 1978; Griffin 1980; Potts and Wiltshire 1997). Porter (1978) reported that temperatures and rainfall in the two to five years before flowering influenced tree growth and honey production of *E. tricarpa* (reported as *E. sideroxylon*), and that a wet winter two years prior to flowering encourages the initiation of a large bud crop. Two years prior to this study (i.e. 1995), Heathcote, Rushworth and Nagambie all received higher than average rainfall over the winter months (Bureau of Meteorology 1998). However, in July 1997 flowering was not heavy or widespread, and variation in rainfall does not account for the geographic patchiness in flowering between different parts of the forest.

Box and Ironbark forests in Victoria have experienced profound changes in the past 200 years of settlement with obvious impacts being the clearing of the majority of the ecosystem and the degradation of most remaining forest fragments (Environment Conservation Council 1997). Although historical data are sparse, available evidence indicates that there has been substantial change in forest structure and tree density (Newman 1961; Environment Conservation Council 1997). The effects of altered forest structure on the availability of suitable hollow-bearing trees for birds and mammals that are oblig-

ate hollow-users has received some attention (Meredith 1984; Traill 1991; Bennett 1993). However, the present results suggest that forest structure also has implications for the presence and abundance of nectar as a resource for nectar-feeding animals. Many birds and mammals, including threatened and migratory species, are dependent on eucalypt nectar in box and ironbark forests. This study has obvious implications for wildlife conservation and forest management. Spatial and temporal patterns in flowering of eucalypt species in box and ironbark forests, and processes influencing these patterns, are being investigated further in ongoing studies.

Acknowledgements

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Effect of a Flood Retarding Basin Culvert on Movements by Platypus *Ornithorhynchus anatinus*

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Abstract

Live-trapping and radio-tracking methods were used to investigate the movements of Platypus *Ornithorhynchus anatinus* through a sizeable concrete culvert (45 metres long), which was built under a soil embankment as part of a flood mitigation system in Melbourne's southeastern suburbs. Five adult or subadult males were recorded crossing the embankment, demonstrating that the culvert does not constitute a barrier to movements by the animals. However, available evidence suggests that Platypus may avoid entering the culvert when engaged in routine foraging, presumably because there is little or no prospect of obtaining food (in the form of aquatic invertebrates) along its length. (*The Victorian Naturalist* **116** (2), 1999, 54-57).

Introduction

By definition, streams and rivers are long and thin. As natural corridors, they serve to facilitate travel, both routine and occasional, by a wide variety of species (Bennett 1990). Creating barriers along linear waterways may be correspondingly detrimental insofar as natural patterns of dispersal or migration are restricted (Koehn and O'Connor 1990) or populations become separated into smaller units that are more vulnerable to local extinction than would otherwise be the case (Shaffer 1981).

Concrete culverts are one of the commonest types of man-made structures found along waterways. We report here on the results of mark-recapture and radio-tracking studies undertaken to assess the potential of a relatively long culvert, built as part of a flood mitigation system, to act as a barrier to Platypus *Ornithorhynchus anatinus*.

The Study Area

Monbulk Creek is a perennial waterway rising on the forested slopes of Dandenong Ranges National Park in the Dandenong Creek catchment. Once outside the park, it flows for about 15 kilometres through public reserves, horse and cattle paddocks, market gardens, and tracts of residential housing before merging with Ferny Creek to form Corhanwarrabul Creek. To reduce the risk of floods occurring along the lower reaches of Monbulk Creek, a flood retarding (or retention) basin was built about 9 kilometres upstream of the Ferny Creek confluence in 1980. The basin includes two lakes which are sufficiently large to hold much of the extra water generated by normal storm run-off. If the capacity of the lakes is surpassed after extremely high rainfall, surplus water is contained by a large grassy embankment located immediately downstream. In both dry weather and after storms, water flowing along the Monbulk Creek channel is conveyed through the embankment by means of a concrete culvert, circular in cross-section, measuring 45 metres in length and 1.35 metres in internal diameter (grade = 1 in 87.5 or 1.1%). Except in the wake of major rainfall, the depth of water flowing through the culvert is typically less than 25 centimetres (Fig. 1).

Methods

Seventeen trapping sites for Platypus were established along Monbulk Creek between Dandenong Ranges National Park and the Ferny Creek confluence, at sites located both upstream and downstream of the retarding basin embankment. The animals were captured in fyke (or eel) nets, set with the length of each net partly suspended out of the water (Serena 1994). Nets were set in pairs in the afternoon, with one net facing upstream and the other facing downstream, and checked throughout the night. Captured Platypus were held in dry calico bags until they could be released at the exact point of capture. Each Platypus was permanently identified with a Trovan transponder tag (Grant and Whittington 1991). Sex and age class were assigned according to spur characteristics,

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Fig. 1. Upstream end of the culvert conveying water from Monbulk Creek through the flood retarding basin embankment.

which enabled juveniles (<1 year old) to be distinguished reliably from older animals. In the case of males, it was also possible to distinguish second-year animals (subadults) from mature individuals (Temple-Smith 1973).

To provide detailed information on the movements of animals living near the embankment culvert, radio-tags were fitted to two Platypus (an adult male and a juvenile female) captured within 0.3 kilometres of the culvert on the evening of 16 May 1997. Briefly, fast-setting epoxy resin was used to attach a miniature radio-tag (Biotrack TW-4 transmitter) to the outer guard fur of the rump (Serena 1994). Diurnal searches for radio-tags were undertaken each day, with burrow locations marked on the bank. Activity was monitored at night by standing near the bank and flagging an animal's position at 5-10 minute intervals, using a TRX-1000S receiver (manufactured by Wildlife Materials). Great care was taken not to alarm active animals, e.g. by ensuring that torch beams were shielded at all times and by remaining still when a Platypus was at the surface.

Results

From February 1996 to November 1998, 24 adult or subadult Platypus were captured on two or more occasions in the Monbulk Creek study area. Thirteen animals (five males and eight females) were recorded only at sites upstream of the flood retarding basin embankment, while six animals (five males and one female) were recorded only downstream of the embankment. The remaining five Platypus (all males) were encountered at sites located both upstream and downstream of the embankment culvert. The locations where these five animals were captured are described in Figure 2 and below:

Male A. Given that Platypus eggs are believed to hatch from September to November in Victoria (Griffiths 1978), A was estimated to be 15-17 months old when first captured as a subadult at Birds Land Reserve in Belgrave (about 2 km upstream of the culvert) in February 1996. He was subsequently encountered in Rowville (at Karoo Road, about 8.5 km downstream of the culvert) in June 1997, and then again in Belgrave (at Mount Morton Road, about 3 km upstream of the culvert) in February 1998.

Male B. B was first captured as a subadult at Birds Land Reserve in January 1997, at the age of 14-16 months. He was next recorded at Karoo Road in June 1997, followed by a site located along Corhanwarrabul Creek in Rowville/Scoresby (about 11 km downstream of the basin embankment) in November 1997, and at Blackwood Park Road (about 4.6 km downstream of the culvert) in September 1998.

Male C. C was first captured as a mature adult in March 1996, at a site located about 3 km downstream of the flood retarding basin. In May 1997, he was recaptured about 0.3 km upstream of the embankment culvert. After being radio-tagged and released, he travelled downstream through the culvert to occupy a burrow near Lysterfield Road (3.3 km downstream of the retarding basin) by early the following morning. C was located in burrows on 30 of the next 34 days and tracked for 7 hours while active in the water. Throughout this time he invariably was found downstream of the retarding basin, although on one occasion he moved to within 50 metres of the embankment before turning around and travelling back the way he had come. C was again captured at a trapping site located about 3 km

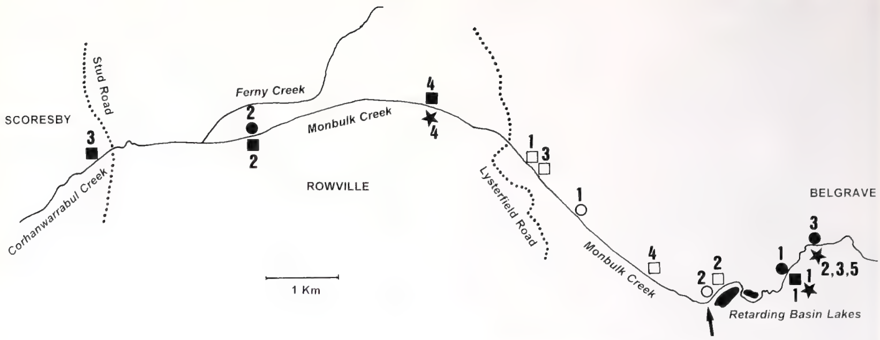

Fig. 2. Locations where male Platypus were captured in fyke nets upstream and downstream of the retarding basin culvert (Melway Map 83, J2). The dates when animals were captured are in brackets. Closed circles, male A (1=02/96, 2=06/97, 3=02/98); closed squares, male B (1=01/97, 2=06/97, 3=11/97, 4=09/98); open squares, male C (1=03/96, 2=05/97, 3=01/98, 4=09/98); open circles, male D (1=03/97, 2=02/98); stars, male E (1=01/97, 2=05/97, 3=09/97, 4=08/98, 5=11/98). The dark arrow marks the location of the upstream end of the culvert.

downstream of the retarding basin in January 1998, and at a site located about 1 km downstream of the retarding basin in September 1998.

Male D. D was first captured as an adult in March 1997, at a site located about 2 km downstream of the retarding basin. He was next encountered about 0.1 km upstream of the embankment culvert in February 1998.

Male E. E was first encountered as an adult in January 1997, upstream of the retarding basin in Birds Land Reserve. He was subsequently captured at Mount Morton Road in May 1997 and September 1997, at Blackwood Park Road in August 1998, and again at Mount Morton Road in November 1998.

While the observations summarised above clearly demonstrate that the culvert through the flood retarding basin embankment does not constitute a barrier to Platypus travelling along the length of the creek, there is some evidence to suggest that the animals may tend to avoid entering the culvert in the course of routine foraging:

(1) No Platypus were captured at a trapping site located 20 metres downstream of the culvert in five nights of surveys undertaken over a 17 month period. In contrast, at least one Platypus was trapped at each of the 16 other survey sites established along Monbulk Creek in the same period (sampled for 2-7 nights), with one or more animals captured on 46 of the 73 occasions that nets were set at these locations (63% trapping success rate). Based on this figure, and assuming that the animals use the area as frequently as other parts of the creek, the probability of not encountering Platypus at the culvert site in five nights of survey work is less than 0.7%.

(2) As described previously, there was no evidence that male C travelled through the embankment culvert in the five weeks following the night he was radio-tagged. Similarly, after being captured and released 0.2 km upstream of the embankment, female E was not found downstream of the culvert in the 50 days that her radio-tag was functional, although she spent 3.5 hours (of the 22 hours she was tracked while active) feeding within 0.1 km of the culvert entrance. As well, E occupied burrows located within 0.1 km of the culvert on 30 of the 49 days she was located diurnally, with her most downstream burrow (occupied on 7 days) located just 25 metres from the entrance.

Discussion

Despite its substantial length, the culvert through the Monbulk Creek flood retarding basin embankment clearly does not prevent Platypus from travelling in either the upstream or downstream direction. One-third (5/15) of the adult and subadult males in this study are known to have crossed the embankment on one or more occasions, in the course of travelling up to 11 kilometres from the retarding basin.

At the same time, evidence from this study suggests that Platypus may avoid using the culvert when engaged in routine

foraging, presumably because there is little or no prospect of obtaining food along the tunnel in the form of aquatic invertebrates (Faragher *et al.* 1979, Grant 1982).

When Platypus are not in the water, they are generally found resting in underground burrows (Grant *et al.* 1992, Serena 1994, Gardner and Serena 1995, Gust and Handasyde 1995, Serena *et al.* 1998). It is therefore not surprising that the animals will enter man-made culverts and pipes, although more work is needed to identify specific conditions which may limit their use by Platypus. In particular, we believe that the following factors merit consideration:

Minimum diameter. Platypus have been known to enter pipes with a diameter of 10 centimetres, although some circumstantial evidence suggests that the animals may not be able to exit from (i.e. back up or turn around in) such a narrow space if it becomes blocked at one end (Taylor *et al.* 1991).

Maximum length. We are unaware of any accounts of Platypus utilising longer culverts than the one described in this report. (Additional information would be extremely welcome in this regard.)

Water flow rate. Platypus will walk across dry land to reach favoured feeding sites (Taylor *et al.* 1991, pers. obs.) and so presumably will travel through dry pipes connecting aquatic habitats. At the other extreme, very strong flows through relatively constricted pipes may well preclude (or at least discourage) travel by Platypus, particularly in the upstream direction (Tyson 1980).

Structural barriers. In Tasmania, Platypus have been killed by cars at stream crossings where a sharp vertical rise made it difficult for the animals to enter a culvert leading under the road (Tyson 1980). A vertical rise of as little as 20 centimetres from the water surface to a culvert lip can apparently preclude entry in the absence of materials (e.g. rocks or an adjoining gravel bank) which assist climbing into the culvert (Otley and le Mar 1998).

Disturbance (e.g. noise). Platypus have been observed to travel routinely under a dual-lane road carrying on average 2-7 vehicles per minute (Serena *et al.* 1998). The effect of more severe disturbance (e.g. from multi-lane freeways) on the animals' use of culverts remains to be assessed.

Acknowledgements

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Sperm Competition: a Marsupial Perspective

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Abstract
This paper examines the concept of sperm competition between males within a female oestrus period and the effects of this competition on male paternity success. The relationship between a species mating system and testes mass, epididymal sperm number and sperm length are discussed. The likelihood of sperm competition occurring in the marsupials is reviewed based upon available reproductive and behavioural data. The influence of copulatory behaviour, mate guarding, presence or absence of mating plugs and sperm transport and storage in the female tract, on the outcome of sperm competition events, are outlined for this group. (*The Victorian Naturalist* **116** (2), 1999, 58-64).

Introduction

The theory of resource competition and natural selection in vertebrates was originally proposed by Darwin in the 1800's and since that time has generated considerable interest among biologists. Much attention has been focussed on the significance of differential success in competition for resources (food, shelter and mates) and its effects on an animal's ability to contribute genes to the next generation. More recently, however, the debate has grown to include discussions of sperm competition and the factors that determine the amount of investment a male makes in sperm production and its relationship to mating strategies and siring success. Much of this theory was developed from studies of insects and birds with relatively few studies conducted in mammals (Birkhead 1995).

Sperm competition occurs when more than one male mates with a female within a single oestrus period (Parker 1970). This in turn leads to competition among the sperm of rival males to fertilise a female's eggs following ovulation, with Parker's theory predicting that the male inseminating the greatest number of spermatozoa will be most successful at fertilising a female's eggs and ultimately at siring progeny (Parker 1970). Morphological and behavioural correlates of sperm competition have been identified in both males and females which suggest that both sexes have evolved mechanisms which maximise their own reproductive fitness (Birkhead 1995).

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Morphological and Behavioural Correlates of Sperm Competition

In males, Parker (1970) suggests that the evolutionary result of such competition is that males have evolved larger testes relative to body mass, and produce greater numbers of spermatozoa. Evidence for this has been found in eutherian mammals and in many other vertebrate groups where there is a clear positive relationship between the testes mass of adults and body mass. For example, in primates, testes mass correlates with the number of sperm ejaculated both within and between species (Short 1979; Harcourt *et al.* 1981; Harvey and Harcourt 1984; Kenagy and Trombulak 1986). Over and above this relationship in primates, there are significant species differences in relative mass of the testes, with species that have relatively large testes generally occurring in multimale breeding groups. Within these groups a female is likely to mate with two or more males during a single oestrus period commonly resulting in sperm competition within the female reproductive tract. Conversely those species that occur in monogamous pairs or as single male breeding groups tend to have relatively smaller testes due to the unlikely occurrence of sperm competition and lower copulatory frequencies (Short 1979; Harcourt *et al.* 1981). In some species this has been taken a step further with animals having relatively large testes in relation to body mass found to produce ejaculates of high sperm counts, high sperm motility and a greater proportion of motile sperm (Møller 1988, 1989). Recently it has been claimed that not only relative numbers of sperm produced, but their relative size too, may

relate to an animal's mating system (Gomendio and Roldan 1991).

Natural selection has also almost certainly favoured females that have some control over fertilisation (Birkhead and Møller 1993) and there is evidence of morphological correlates of sperm competition in the female. For instance, the length and complexity of the female reproductive tract has been associated with sperm colonisation rates and sperm competition (Birkhead and Møller 1993). Structures such as the cervix and utero-tubal junction in eutherian mammals act as selective barriers to sperm advancement up the reproductive tract (Hunter 1988). In addition, females of many invertebrate and a number of vertebrate species, store sperm in specialised structures before using them to fertilise their eggs (Birkhead and Møller 1992). In some species the number, design and size of these receptacles or the mode of sperm release from them have also been implicated in patterns of sperm precedence (Birkhead and Møller 1992).

A wide range of behavioural adaptations which help prevent competition by sperm from another male have also been identified (Birkhead 1995). These include the presence or absence of mating plugs, prolonged or frequent copulation and the instance and duration of mate guarding. In a similar manner females of some species have evolved lengthy periods of oestrus which increase the likelihood of multiple mating and would appear to actively promote sperm competition between males (Birkhead 1995).

The reproductive fitness of many species is therefore affected by the mechanisms which determine sperm competition success. Some of these will now be reviewed for the Marsupialia.

Studies In Marsupials

Testes Size, Sperm Number and Sperm Length

Until very recently, little information was available on sperm competition in any marsupial (Tyndale-Biscoe and Renfree 1987; Dickman 1993; Rose *et al.* 1997; Taggart *et al.* 1998). However, like eutherian mammals and other vertebrate groups, recent studies in marsupials have found that there is a positive relationship between body mass and testes mass (Rose *et al.* 1997; Taggart *et al.* 1998). Deviation from the expected testes mass relative to body mass can be used to predict the likelihood of sperm competition occurring. For example the Honey Possum *Tarsipes rostratus*, Feathertail Glider *Acrobates pygmaeus* and most macropods have large testes relative to body mass, thus suggesting that the likelihood of sperm competition occurring within these species is high. In contrast, the Mountain Pygmy Possum *Burramys parvus*, Sugar Glider *Petaurus breviceps*, wombats and Koala *Phascolarctos cinereus* have small testes relative to body mass. As might be expected, epididymal sperm counts for some of the representatives of the macropod lineage (e.g. the Western Grey Kangaroo *Macropus fuliginosus* and Red-necked Wallaby *Macropus rufogriseus*) with a large testes-body mass ratio are correspondingly high relative to body mass whilst epididymal sperm counts of the Southern Hairy-nosed Wombat *Lasiorhinus latifrons*, which has a low testes:body mass ratio, are likewise low relative to body mass (Taggart *et al.* 1998).

In contrast to the data for testes mass and sperm number, a negative relationship has been found between sperm tail length and body mass across all marsupial species. In species like the Honey Possum, which has the distinction of having the largest mammalian spermatozoa (Cummins and Woodall 1985), and the Dusky Antechinus *Antechinus swainsonii* for example, the value for sperm tail length relative to body mass is higher than would be expected for animals of that weight, thus supporting previous data which suggested that sperm competition may occur in these groups. In contrast the data for Petaurids indicates that sperm from this group are short relative to body mass, suggesting the existence of a monogamous type relationship in species within this group (Rose *et al.* 1997, Taggart *et al.* 1998).

As mentioned, a variety of behavioural and morphological factors also influence the outcome of sperm competition events. Comparisons of how testes mass, sperm number and sperm length compare with these other factors allows relatively accurate predictions to be made of the likelihood of sperm competition occurring with-

in a particular species and the mating system employed. Some of these additional factors are considered below.

Copulatory Behaviour

With the exception of dasyurid and macropod marsupials few detailed observations have been made on copulatory behaviour in marsupials (Table 1). In dasyurids the length of copulation varies from 2-18 hrs depending upon the species (Table 1). In general, the semelparous dasyurid species, like the Agile Antechinus *Antechinus agilis* have the longest copulation (~7.7-18 hours). Lengthy copulations have also been reported in some didelphids (>6 hours). In contrast, the macropods mate for between 5-50 minutes, wombats for approximately 30 minutes, and other didelphids for 4-40 mins (Table 1). The shortest copulation (less than 30 seconds) has been reported for bandicoots (Table 1) (Taggart *et al.* 1998).

During detailed studies on copulatory behaviour in the Agile Antechinus (previously Brown Antechinus/Brown Marsupial Mouse *Antechinus stuartii*) (Shimmin 1996, 1998) it was found that the time at which males were given access to females within the oestrus period dramatically influenced the length of copulation. However, factors such as order of mating and delay between two rival males securing mating access had little effect on the duration of mating. Furthermore, mating behaviour varied significantly during the extended period of copulation. Males pursue females and tolerate high levels of female and subdominant male aggression whilst maintaining intromission and ensuring mating success. Females, however, can prevent male mating access in a similar manner to which they initiate the final dismount, through massive bouts of kicking and fighting. Subdominant males rarely force the dominant male to dismount (Shimmin 1998).

Amongst macropods the Tammar Wallaby *Macropus eugenii* has been the most extensively studied (Tyndale-Biscoe and Renfree 1987). Female tammars come into oestrus within hours of giving birth, whereas in the Swamp Wallaby *Wallabia bicolor* oestrus occurs 3 days before birth and in the Red Kangaroo *Macropus rufus* 2 days after birth. In some other macropod species it does not appear to be related to birth. In tammars, Whip-tailed Wallabies *Macropus parryi* and Red-necked Wallabies, females are vigorously pursued by the males within the group following birth and the initiation of oestrus. Intense inter-male aggression results from these mating chases and, in the tammar at least, results in delaying the time of the first successful ejaculation until 1-2 hrs post-partum (Rudd 1994). The first ejaculation is

Table 1. Maximum length of copulation in various marsupial species.

Marsupial Family	Species	Maximum Duration of Copulation
Dasyuridae (Semelparous)	Agile Antechinus *Antechinus agilis*	18.0 hrs
	Dusky Antechinus *Antechinus swainsonii*	9.5 hrs
	Yellow-footed Antechinus *Antechinus flavipes*	11.0 hrs
Dasyuridae (Iteroparous)	Fat-tailed Dunnart *Sminthopsis crassicaudata*	11 hrs
	Kowari *Dasyuroides byrnei*	3.0 hrs
	Stripe-faced Dunnart *Sminthopsis macroura*	2.5 hrs
	White-footed Dunnart *Sminthopsis leucopus*	1.8 hrs
Peramelidae	Long-nosed Bandicoot *Perameles nasuta*	<30 sec
Potoroidae	Long-nosed Potoroo *Potorous tridactylus*	2 min
Macropodidae	Eastern Grey Kangaroo *Macropus giganteus*	50 min
	Parma Wallaby *Macropus parma*	5 min
	Red Kangaroo *Macropus rufus*	15-20 min
	Red-necked Wallaby *Macropus rufogriseus*	8 min
	Tammar Wallaby *Macropus eugenii*	8 min
Vombatidae	Southern Hairy-nosed Wombat *Lasiorhinus latifrons*	30 min
Didelphidae	Grey Short-tailed Opossum *Monodelphis domestica*	4-40mins
	Mouse Opossum *Marmosa robinsoni*	>6hrs

Semelparous – all offspring produced at one time; Iteroparous – offspring produced in successive groups.

usually secured by the dominant (alpha) male, which is usually the largest male within the group. Bouts of thrusting activity are observed in the tammar throughout copulation with males ejaculating after each bout (although the components of each ejaculate are not known).

Mate Guarding

In antechinus, pelvic thrusting by the male during the extensive copulatory period is greatest early in the mount time and declines towards the end of copulation. This reduced activity in the later hours of copulation is consistent with contact mate guarding behaviour which has been reported for other vertebrate species. Mate guarding of this nature also assists in ensuring efficient sperm transport and storage, and therefore increases the likelihood of siring success (Shimmin *et al.* 1997).

In the Tammar Wallaby, the dominant male always copulates and ejaculates first (Jarman 1983), and subsequently guards the female from the advance of other males (by chasing, biting and kicking) for up to 8 hours. In macropods, subordinate male tammars, Red-necked Wallabies and Red Kangaroos that are not involved in mating, respond to the mating activity by the dominant male by biting and kicking the copulating male until he releases his hold on the female (Sharman and Calaby 1964; Johnson 1989; Rudd 1994). After the dominant male has finished guarding the female, some subordinate males may mate with her. In tammars and Red-necked Wallabies the dominant male has considerable mating advantages over subordinate males in terms of timing, and is probably the most reproductively successful. As ovulation does not occur until 40 hours after birth in the latter species, it is likely that the copulatory plug deposited by the dominant male plays a significant role in ensuring a high rate of paternity success (Tyndale-Biscoe and Rodger 1978).

In Long-nosed Bandicoots *Perameles nasuta*, males closely follow the females for several nights preceding copulation, and, although length of copulation is short (<30 seconds), the frequency is quite high with successive mounts occurring at intervals of several minutes. A peak in activity occurs ~2 hours later when about 13 mounts with intromission follow in quick succession. This is followed by a steady waning in attraction (Stoddart 1966, 1977). Whether multiple ejaculation occurs during this period has not been determined. A similar pattern of multiple, but brief, copulations has also been reported in members of the Potoroidae (Seebeck and Rose 1989) and is also thought to act as a type of mate guard.

For the Grey Short-tailed Opossum *Monodelphis domestica*, only a single intromission/ejaculation per male has been observed, whereas in the Woolly *Didelphis albiventris* and Virginia Opossums *Didelphis virginiana* there are multiple intromissions and/or ejaculations (Dewsbury 1972). Locking at the conclusion of mating immediately prior to dismount is also a feature of copulation in many didelphid opossums and has also been observed in the Yellow Footed Antechinus *Antechinus flavipes* and Agile Antechinus.

Prevalence of Mating Plugs

Copulatory plugs have been observed in the urogenital sinus and/or lateral vaginae following mating and ejaculation in opossums, macropods, phalangerids, vombatids, dasyurids and the Numbat *Myrmecobius fasciatus* (Hughes and Rodger 1971; Tyndale-Biscoe and Rodger 1978; Taggart *et al.* 1997; Taggart and Friend *unpubl. obs.*). The copulatory plug is thought to result from the mixing of semen and vaginal secretions, however coagulation can occur in the absence of female tract secretions in macropods. In Tammar Wallabies the mating plug is devoid of spermatozoa soon after ejaculation (Tyndale-Biscoe and Rodger 1978). It appears as a pale creamy coloured rubbery mass, and in macropods can often be seen protruding from the urogenital sinus for up to 24 hours after mating. Copulatory plugs in marsupials may prevent leakage of spermatozoa, act to retain spermatozoa in the vaginae close to the cervical canal thus ensuring maximal access for spermatozoa to the cervix, and/or perhaps act as a temporary physical barrier to subsequent matings by other males.

Sperm Transport in the Female Reproductive Tract

In marsupials, upon ejaculation, semen is deposited in the upper part of the urogenital sinus and sperm travel rapidly to the cervix, which may act as a reservoir for spermatozoa as well as a selective barrier to further sperm transport. In didelphid and dasyurid marsupials there appears to be extremely efficient transport of ejaculated spermatozoa from the urogenital sinus to the lower isthmus region of the oviduct (~1 in 7) suggesting little if any barrier to sperm transport up the female reproductive tract in species from these groups. This contrasts dramatically with the small percentage of ejaculated spermatozoa (~1 in 10,000) which reach the oviduct in most macropods studied (Bedford *et al.* 1984; Tyndale-Biscoe and Rodger 1978; Taggart and Temple-Smith 1991).

Sperm Storage and Release in the Female Reproductive Tract

Sperm storage in the female reproductive tract is a relatively common phenomenon in insects, lower vertebrates, reptiles and birds. In eutherian mammals, as fertilisation generally occurs within 24 hours of mating, spermatozoa only survive for short periods in the female tract. Long term sperm storage in this group is therefore extremely rare, with insectivorous bats being the most well-known exception (Racey 1979). In marsupials, extended periods of sperm storage in the female tract (up to 2-3 weeks) have been reported for three families. In the Dasyuridae (Bedford *et al.* 1984; Selwood and McCallum 1987; Breed *et al.* 1989; Taggart and Temple-Smith 1991) and the Didelphidae (Rodger and Bedford 1982; Bedford *et al.* 1984) sperm storage occurs in specialised crypts in the lower oviduct, whereas in peramelids (Lyne and Hollis 1977) it occurs in the vaginal caeca. Observations on the release of spermatozoa from the isthmic storage crypts have been studied in the Fat-tailed Dunnart *Sminthopsis crassicaudata* using transmitted light and suggest that those located closest to the ovary are the first to be released from the crypts following ovulation (Bedford and Breed 1994), and are perhaps therefore more likely to successfully fertilise any ovulated eggs.

Paternity Studies

The best evidence for sperm competition within marsupials has come from studies of captive colonies of two dasyurid species, the Agile Antechinus (Shimmin 1998; Shimmin *et al.* 1997) and the Brush-tailed Phascogale *Phascogale tapoatafa* (Millis *et al.* 1995). Both studies examined paternity within litters associated with competitive mating trials between two males. These studies indicate that spermatozoa from more than one male can concurrently occupy the sperm storage crypts in the lower oviduct prior to ovulation, and also that multiple paternity can occur within the one litter. Fertility studies undertaken in the Agile Antechinus suggested that spermatozoa from second and third inseminations can contribute spermatozoa for fertilisation. In studies on the Agile Antechinus, of the 61 young on which paternity was assigned 72% were sired by the second mating male when both matings occurred early in oestrus, 62% were sired by the second mating male when one mating occurred early and one in mid oestrus and 58% were sired by the second mating male when both matings occurred in mid oestrus. Overall, 64% of young were sired by the second mating male. Importantly, however, large numbers of the litters (7/11) were sired by both males given access to the female (Shimmin 1998; Shimmin *et al.* 1997). This result proves that effective storage of each male's sperm occurs and that males securing mating access early in oestrus are also gaining some siring success. Production of mixed paternity litters significantly increases the genetic diversity of the litter and, combined with the sex-biased dispersal of young, ensures that high levels of genetic heterozygosity are maintained in the population. Support for these findings also come from field studies of the Agile Antechinus in which radionuclide labels, individually recognisable by their spectral properties, were injected into males at the beginning of the breeding period. Labels passed to females during ejaculation were identified and counted following female capture to determine male mating success, and subsequently demonstrated that males and females did indeed exhibit a promiscuous mating strategy in the wild (Scott and Tan 1985).

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The relationship between male dominance and paternity has been examined in captive colonies of Red-necked Wallabies and Tammar Wallabies using electrophoretic and DNA fingerprinting techniques. Within groups of Red-necked Wallabies the dominant male sired at least 70% of young surviving to the age of pouch emergence with 30% or less young surviving being sired by subordinate males (Watson *et al.* 1992).

Conclusion

Sperm competition is an important selective force which affects the reproductive fitness of many invertebrate and vertebrate species. Unfortunately the comprehensive testing of many of the predictions associated with sperm competition theory remains to be done. As the behavioural, morphological and quantitative correlates of sperm competition vary dramatically across the marsupial fauna, the study of this group of mammals offers a unique opportunity to test many of the predictions which remain unresolved in mammals and will help determine how the various factors that influence the outcome of sperm competition events affect male and female reproductive fitness.

Furthermore, when data on relative testes-body mass and sperm number-body mass are examined with other behavioural and morphological data for a particular species, this information can be used to help assess the likelihood of inter-male sperm competition occurring within a particular species and thus predict the likely mating system in operation (for example monogamy, promiscuity). In addition, a better understanding of paternity within mating systems and the natural strategies for enhancing intraspecific genetic diversity will assist conservation objectives and provide a new, useful and potentially rich area for further investigation.

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A Rare Sighting of the Common Dolphin *Delphinus delphis* in Port Phillip Bay, Victoria

Carol Scarpaci[1], Stephen W. Bigger[1],
Troy A. Saville[3,4] and Dayanthi Nugegoda[1,2]

Abstract
This paper reports a sighting of two Common Dolphins *Delphinus delphis* off Blairgowrie in Port Phillip Bay, Victoria. Once the dolphins were sighted they were continously observed using an instanteous sampling technique to document focal group activity. The Common Dolphins were continously observed for a total of four hours. The preferred shore distance of these Common Dolphins was 150 m in a water depth of 10–15 m. The most common behaviour observed was feeding behaviour (87.5%) followed by social behaviour (10.4%) and travel behaviour (2.1%). Two whistles and one echolocation pulse were recorded during the observation period. (*The Victorian Naturalist* **116** (2), 1999, 65-67).

Introduction

On 15th November 1995, an opportunistic sighting of two adult Common Dolphins *Delphinus delphis* was made off Blairgowrie in Port Phillip Bay, Victoria (38°21.5'S, 144°46'E) (Fig. 1). The sighting occurred during a field study on Bottlenose Dolphins *Tursiops truncatus* (Scarpaci 1997) in the vicinity of the Blairgowrie Yacht Club, which is recognized by the local fishermen as a relatively good fishing spot. The Common Dolphins were observed continously between 1000 and 1400. All observations made in this paper are within the Australian Whale Watching Regulations. A minimum distance of 100 m was maintained by the research boat from the dolphins unless the dolphins approached the vessel of their own accord.

Identification

The dolphins were identified as the species *Delphinus delphis* (Fig. 2) on the basis of the following criteria: (i) a distinct, triple coloration was observed on their body (Aguayo 1975) and this consisted of a 'criss-cross' pattern as proposed by Baker (1983); (ii) the dorsal sector of the cross was dark grey, the ventral sector was white, the posterior sector was grey and the interior part was a creamish-tan color; (iii) the body size of each of the two Common Dolphins was considerably smaller than that of the Bottlenose Dolphin observed in the area, the rostrum was longer and the dorsal fins were relatively higher than those of the Bottlenose Dolphin. Data collected from a total of 10 strandings off the Victorian coast indicate body lengths of Common Dolphins range from 1.7–1.9 m (Warneke 1995) whereas the typical size of adult Bottlenose Dolphins in Australian waters ranges from

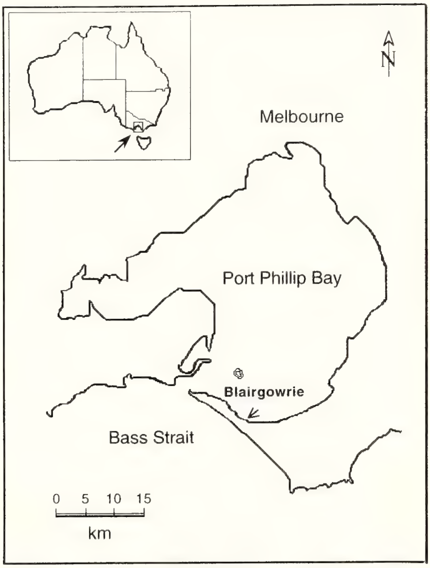

Fig. 1. Map of Port Phillip Bay, Victoria, showing the region where the Common Dolphins were observed.

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Fig. 2. Common Dolphin *Delphinus delphis*, showing the distinct 'triple colouration' of the body. **Note**: these animals are not the individuals described in this paper. Photo kindly supplied by David Donnelly and sourced by the Dolphin Research Institute Inc., Frankston.

1.78–3.26 m (Ross and Cockcroft 1990), the largest of which are found in Tasmania, southern Victoria and South Australia. These distinct features were easily observed due to good water clarity and the frequent approaches made by the dolphins towards the research vessel. According to Jefferson *et al.* (1993) two types of Common Dolphin exist: a long-beaked (coastal) and a short-beaked (offshore) variety. Unfortunately, we were unable to distinguish if these dolphins were short-beaked or long-beaked.

Behaviour and Vocalisations

Once the Common Dolphins were observed an instantaneous sampling technique (Shane 1990) was used to document the focal group. The two Common Dolphins were defined as the focal group. Focal group activity was documented at five minute intervals. The behavioural activities of the dolphins were grouped into three categories: travel, social and feeding, as defined by Shane (1990). Data on their location, distance from shore and water temperature were also noted.

Vocalizations by the Common Dolphins were recorded using a hydrophone attached to a preamplifier. A standard tape recorder with a tape speed of 19 cm/sec was used. Recordings were later transformed into a frequency time wave (spectrograph) on a computer work station with the aid of specialized computer software (*Avisoft*®) co-ordinated to a printer.

The dolphins spent most of their time feeding (87.5%) in the area with little indication of social (10.4%) or travel behaviour (2.1%). This is unlike the behaviour of the Bottlenose Dolphins studied by Scarpaci (1997) in Port Phillip Bay. The dolphins remained an average distance from the shore of 150 m, in a water depth of 10–15 m; the water temperature was 19°C. A study conducted by Silber *et al.* (1994) showed that Common Dolphins normally inhabit relatively clear regions at

a distance greater than 15 km from the shore where water depths are usually greater than 30 m. The typical group size of the Common Dolphin can range from several dozens to over 10 000 animals (Jefferson *et al.* 1993). However, on this occasion only two dolphins were sighted. Possible reasons for this may be: (i) the dolphins dispersed from their main group to forage; (ii) the dolphins dispersed from the main group for reproductive purposes; (iii) the dolphins may have formed a solitary group of their own; (iv) this was not a typical dolphin group, or (v) Common Dolphins may not always be in large groups.

Two whistles and one echolocation pulse were recorded during the observation session, with one whistle being clear enough to analyze. The duration of the whistle was 0.3 sec over a frequency range of 2.7 kHz to 4.0 kHz (Fig. 3). Generally, whistles of Common Dolphins start at 4 kHz and can sweep as high as 15 kHz, with harmonics to 30 kHz (Evans 1994). Echolocation pulses of Common Dolphins are extremely short in duration (20–50 μsec), with energy levels between 15 and 100 kHz (Evans 1994).

Comments

The Common Dolphin is widely distributed (Evans 1994) in all tropical and temperate seas (Warneke 1995). Common Dolphins are found both in shallow coastal environments and in deep oceanic water (Warneke 1995). Common Dolphins have been widely recorded in Australia, including Victoria, where it is the second most frequently stranded cetacean (Warneke 1995). However, unlike the Bottlenose Dolphins they do not appear to be resident in Port Phillip Bay but rather a casual visitor (Warneke 1995).

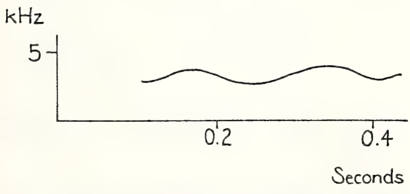

Fig. 3. Sound spectrogram of whistle emission by a Common Dolphin, *Delphinus delphis,* in Port Phillip Bay, Victoria.

The two Common Dolphins reported here were observed on only one occasion. No further sightings of these or any other Common Dolphins occurred in the period from September 1995 to March 1996 and January 1997 to November 1998 during which continuous field observations of Bottlenose Dolphins were recorded in Port Phillip Bay.

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Moonraker Dolphin-Seal Swim Charters for the essential provision of a research vessel.

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Calomnion complanatum: an Endangered Moss found in Victoria

David Meagher[1]

A collection of bryophytes from wet forest on Wilsons Promontory has yielded specimens of the moss *Calomnion complanatum* (Wilson) Lindberg, one of only four mosses that are endangered in Australia (Scott *et al.* 1997). This species is apparently common in suitable habitat in New Zealand (Beever *et al.* 1992), but is known in Australia with certainty only from two previous collections: by W.W. Watts in New South Wales in 1903, and by Ilma Stone near Stanley, Tasmania, in 1980 (Stone 1990). An earlier record attributed to Tasmania (Whittier 1976, page 181) is thought to be an error (Stone 1990).

The habitat in Tasmania and Victoria is the trunks of Soft Tree-ferns *Dicksonia antarctica*, and in New Zealand also almost always on certain tree-fern species (Beever *et al.* 1992). Because the shoots grow almost horizontally out from the tree-fern trunk, they are easily mistaken at first glance for other tree-fern mosses of a similar size and habit, especially *Rhizogonium distichum*, *R. novaehollandiae*, *Hymenodon pilifer* and young shoots of *Lopidium concinnum*. *Calomnion*, though, is unique in having a row of almost circular leaves on the dorsal (upper) side of the stem (Fig. 1). Sainsbury (1955) mistakenly described this row as 'ventral'.

The yellow-green shoots are 10 to 15 mm long, erect, unbranched and very delicate, arising from creeping caulonema. The leaves are in three ranks, little altered when dry. Two rows (the lateral rows) are almost opposite on the stem. The ovate to obovate leaves of these lateral rows increase in size towards the stem apex, widely spaced on the lower stem but more closely arranged and rather oblong at the apex. The leaves of the third (dorsal) row are roughly circular all the way up the stem and are very variable in size, but tend to be larger towards the stem apex. The tips of these leaves are turned upwards.

All leaves are strongly nerved, the nerve reaching the apex in the lateral leaves and shortly excurrent in the dorsal leaves. The leaf margins are irregularly denticulate to entire. Cells in mid-leaf (similar in all leaves) are smooth and thin-walled, shortly rectangular to pentagonal but tending to be square or over-square near the leaf margins. I have not seen sporophytes, but they are described in detail in Sainsbury (1955). Scott *et al.* (1997) gave this species a '3E' conservation status. That is, it is considered to be in danger of extinction in Australia or is unlikely to survive if the factors that threaten its survival continue to operate, and it is highly localised but has a range of more than 100 km. As the Victorian population appears to be confined to small colonies on only five tree-ferns in an area where there is a considerable risk of natural or unnatural disturbance, this status is still appropriate.

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Acknowledgements

Thanks to Ilma Stone for an enlightening discussion on her collection of *Calomnion complanatum* from Tasmania; Phil Wierzbowski of the Arthur Rylah Institute for helping to find and map the population; Paddy Dalton of the University of Tasmania for advice on his own collection and that of Gunn; and the rangers at Wilsons Promontory National Park for their support and assistance.

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Addendum

Since I prepared this article for publication, Paddy Dalton has told me that Whittier's Tasmanian record is probably attributable to a collection by R.C. Gunn held by the New York Botanic Gardens (NY). Paddy has also recently found another population in Tasmania, near Strahan (see *Papers and Proceedings of the Royal Society of Tasmania* **132**: 41-5).

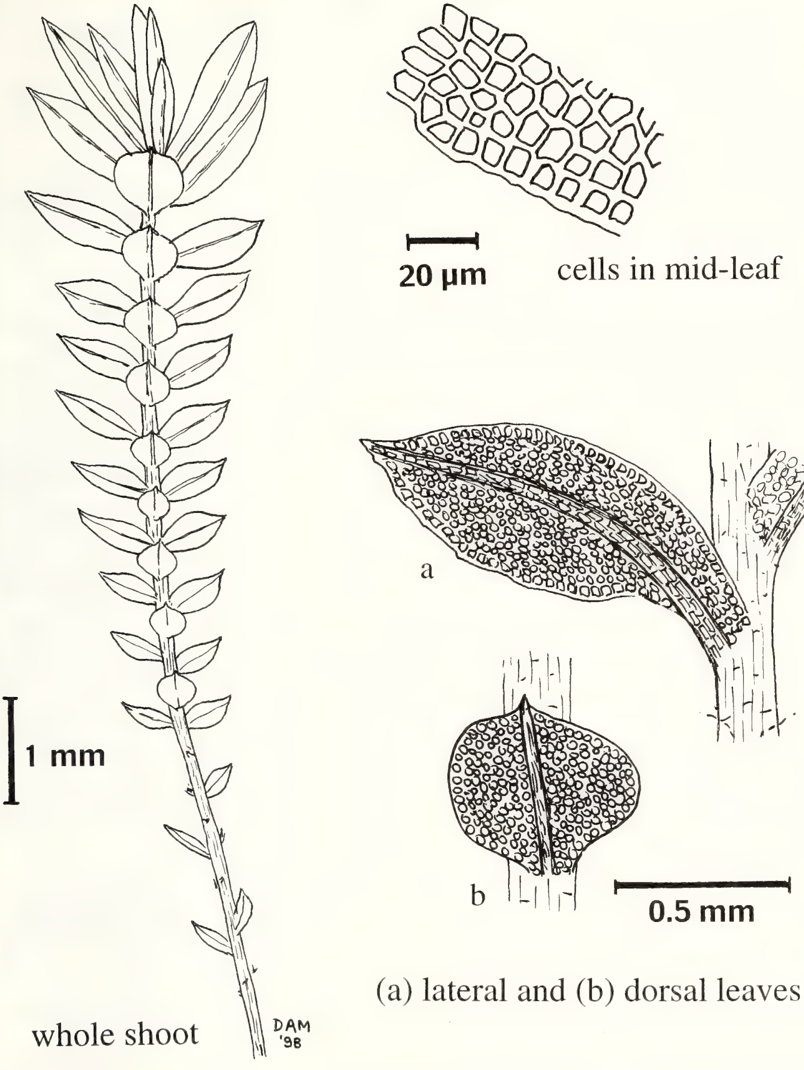

Fig. 1 *Calomnion complanatum* (Wilson) Lindberg: shoot (dorsal view), cells of lateral leaf in mid-leaf, lateral leaf (ventral view) and dorsal leaf (drawn from herb. D.A. Meagher 01636).

For assistance with the preparation of this issue, thanks to the computer team - Alistair Evans and Anne Morton. Thanks also to Felicity Garde (label printing) and Michael McBain (web page).

The Biography Behind the Bird: Grey Honeyeater *Conopophila whitei* (North 1910)

Tess Kloot[1]

Abstract
This paper describes the naming of the Grey Honeyeater *Conopophila whitei,* the part played in its naming by the Field Naturalists Club of Victoria and a brief biography of Alfred Henry Ebsworth White after whom the bird was named. (*The Victorian Naturalist* **116** (2), 1999, 70-72).

Introduction

Over ninety Australian birds commemorate individuals who have made a valuable contribution to our ornithology. Tracing the original publication that named and described a particular species is a fascinating aspect of bird lore. The scientific naming of a species is equally absorbing, as is the translation of the Latin and Greek names (see glossary).

Priority is paramount in the naming of a new species, hence publication of the find, description of the species and explanation of its name are all important. The Grey Honeyeater *Conopophila whitei*, with its stronghold in Western Australia, inhabits dense spinifex and thickets of mulga and other acacias. An inconspicuous little bird, occupying mainly inaccessible areas, it was discovered at Lake Way, East Murchison District, on 19 July 1909 by F. Lawson Whitlock. It was officially named by Alfred J. North, Ornithologist to the Australian Museum, Sydney, in *The Victorian Naturalist* in 1910.

This article is No.7 in a series reproducing the actual published note naming the bird and including a brief biography of the person after whom the bird was named. Previous biographies in this series cover George Arthur Keartland (Kloot 1997), Thomas Carter (Kloot 1997/1998), John Latham (Kloot 1998), Edwin Ashby and James Robert Beattie Love (Kloot 1998), Elizabeth Gould (Kloot 1998) and Keith Hindwood (Kloot 1999).

As the naming of the Grey Honeyeater is associated with the Field Naturalists Club of Victoria it might be of interest to members to learn something of its story.

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Naming the Bird

'Description of a new genus and species of honey-eater from Western Australia.'
(Read before the Field Naturalists' Club of Victoria, 13th December, 1909).
Remarks ... *Lacustroica inconspicua* would fittingly designate this modestly plumaged little Honey-eater inhabiting the vicinity of Lake Way, but in response to a request from the owner of the specimens [H.L.White], who has done so much recently to advance Australian ornithology, I have associated with it the name of his son, Mr Alfred Henry Ebsworth White, who, although yet young in years, I am informed is worthily following in his father's footsteps. Although generically allied to *Entomophila*, White's Honeyeater is an entirely new and distinct species, having no near ally, and may easily be distinguished from any other member of the family Meliphagidae inhabiting Australia.' (North 1910).
We now know it as the Grey Honeyeater *Conopophila whitei* (Christidis and Boles 1994) (Fig. 1).

Fig. 1. Grey Honeyeater *Conopophila whitei*. Reproduced from 'Atlas of Australian Birds' (1984), M. Blakers, S.J.J.F. Davies and P.N Reilly (Royal Australasian Ornithologists Union, MUP Melbourne). By Richard Weatherly, with permission from the artist and Birds Australia.

The Biography.

ALFRED HENRY EBSWORTH WHITE (1901-1964)

Alfred Henry Ebsworth White (Fig. 2) slipped into the history of Australian ornithology on the crest of the wave of his father's fame. His father was Henry Luke White (1860-1927), the noted collector of birds' eggs and skins. The H.L.White Collection of eggs and skins, in their very fine cabinets made expressly for the purpose, were donated by him to the Victorian Museum where they remain today (Whittell 1954).

Alf, as he was known, was born at 'Belltrees', New South Wales, on 18 October 1901. After two daughters his father was so delighted at his birth that he decided to build a new homestead, the present day 'Belltrees'.

Wanting his son to follow in his own footsteps, H.L.White enrolled him in the [Royal] Australasian Ornithologists' Union at the age of eight, the youngest member ever. Alf attended Geelong Grammar School and although he did well scholastically his real love was cricket, a sport at which he excelled. He also acquired a rare knowledge of world geography. A religious lad, Alf was awarded a divinity prize. At school during the 1914-1918 war he wanted to enlist but his father refused to allow him to put up his age. He stayed on at Geelong Grammar School until 1921, then went on to attend Jesus College, Cambridge. By this time his prowess in the cricket world was well known. He played for Cambridge against South Africa, taking vital wickets and at the conclusion of the match was 53, not out. For his splendid efforts on behalf of the team he was awarded his cricket blue. Returning to 'Belltrees' in 1924, his father put him straight to work. The property was now a well established pastoral concern and with the increased work load H.L.White was very happy to have his son beside him.

Fig. 2. Master Alfred H.E. White of Belltrees Scone, September 1909. Reprinted from 'The White Family of Belltrees' (1981), by Judy White (The Seven Press, Sydney), with permission from the author. Photo by S.W. Jackson.

Alf married Judy Coombe on 20 September 1926, but by this time his father was too ill to attend the wedding (White 1981). Four children were born to the couple, one son and three daughters.

After the death of H.L.White in 1927 the full responsibility for 'Belltrees' fell on Alf's 26-year-old shoulders, and from then on he devoted his life to the property. A strict, but just man, he earned respect from both friends and employees. Despite the depression of the 1930s he drove his staff to maintain high standards. Dictatorial and impulsive he rejected criticism. However, this stern facade concealed his shyness and gentle manner.

A stickler for tidiness, Alf was constantly engaged in clearing away such things as unused workmen's cottages and sadly, valuable ornithological data from his father's library. On the other hand he realized the historic value of some of the early buildings, and employed one of the best bush workers, a fencer who understood round timber and was brilliant with a mortising axe and adze, to restore an old slab store.

Ultimately, 'Belltrees' carried sheep, cattle and horses. During the 1950s, seasonal prices were good and the family enjoyed great prosperity. Over the desk in his office Alf had pinned his motto, 'The best fertiliser of any country is the footsteps of the owner' (White 1981).

H.L.White had been strict with his children and Alf carried on this tradition with his own, although he mellowed in later years. When his eldest daughter asked her father's permission to announce her engagement he suddenly realized how 'Belltrees' had been his first concern to the

neglect of family life. By about 1952 the 'despotic camouflage' (White 1981) started to disintergrate and revealed a much kinder and approachable person. A very proud grandfather, he fired a twenty-one gun salute from the top balcony of the homestead to announce the arrival of the first White grandson!

The last ten years of Alf's life were filled with contentment. 'Belltrees' had reached a very high standard of excellence; the stock, property, buildings and fences were in immaculate condition. He had attained his goal and felt that he could now delegate responsibilities to his only son, Michael. He and his wife travelled widely, both within Australia and overseas. Christmas, when the entire family gathered at 'Belltrees' were perhaps his happiest times.

Alfred died suddenly on 6 March 1964. Although he made no real contribution to ornithology and will be remembered as the son of the famous Henry Luke White, he deserves a place in our ornithological history, with his name perpetuated in the Grey Honeyeater *Conopophila whitei*.

Glossary:

Conopophila whitei - *conops*: gnat, *philos*: fond of, *whitei*: after Alfred H.E. White son of H.L. White.
Lacustroica - *lacus*: lake, *oicos*: house.
inconspicua - inconspicuous.
Entomophila - *entoma*: insects, *philos*: fond of.
Meliphagidae - *meli*: honey, *phagein*: to eat. (Wolstenholme 1926).

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One Hundred Years Ago

NOTES ON THE BIRDS OF THE BOX HILL DISTRICT

By Robert Hall

(Read before the Field Naturalists' Club of Victoria, 13th February, 1899)

'In this, the concluding paper of the series on the birds of the Box Hill district, I wish to bring under your notice the introduced birds of the district, which number in all seven species. Six of them, viz., the Thrush, Blackbird, Goldfinch, Greenfinch, Sparrow, and Starling, are imports from Western Europe, while the seventh is the Indian Myna. All are town birds, and pass their time in close proximity to the little townships of the district, especially Box Hill proper......

'I will conclude with a brief recapitulation of the birds dealt with in these notes. Altogether 113 species, including the introduced birds, have been referred to, besides which there are some 10 species which are only very casual visitors. Approximately, 43 of these reside with us all the year round, while 70 are migrants, arriving here with the advent of spring. Sixty species have been found breeding here. Grouping them according to their rarity, I would say that 42 are common, 43 less common, and 28 rare. Birds of prey are represented by 8 species; passerine birds, 88; parrots, 9; pigeons, 1; game birds, 2; hemipodes, 1; and waders, 5.'

The Victorian Naturalist ***XV****, pp 156-159. April 1899.*

Jean Galbraith
28 March 1906 – 2 January 1999
A Tribute

Helen I. Aston[1]

The death of Jean Galbraith, aged 92 years, marks the end of a lifetime of service to botany, naturalists, natural history organisations and gardeners, and the passing of a truly loveable and remarkable woman.

Jean was born at Tyers, near Traralgon, Victoria, on 28 March 1906 and lived there for most of her life. For 79 years she lived in her beloved home of 'Dunedin', only leaving it in July 1993 with great reluctance but with full acceptance of her need for care in advancing years. She moved first to a unit at 'Yallambee' village in Traralgon and then in 1996 to 'Olivet' nursing home at Ringwood, Melbourne, where she died peacefully on 2 January this year.

From early childhood Jean displayed a great love of the natural world and a sensitivity and wonderment at its beauty and diversity. Her enjoyment of natural things and of life in general was intense, her enthusiasm infectious, and her hospitality legendary. Friends and visitors alike were welcomed to her home and those in trouble or in sorrow turned to her. She held a deep Christian (Christadelphian) faith which sustained her at all times and shines through in her writings.

Although Jean had limited formal education, leaving school at the age of 14, she read avidly on wide-ranging topics from the classics to science. By the age of 19 she herself was already a published author, although her major works were still to come. Her enthusiasm for writing never waned, and besides the main gardening and botanical publications mentioned below she wrote poetry and several books and many articles for children.

Both of Jean's parents were keen gardeners, and gardens were also a major passion in Jean's life. It was Jean and her parents who designed and developed the garden at 'Dunedin', which Jean tended and maintained until prevented by age. She wrote about it, showed people through it, and treasured both its plants and the many birds which came to it. Although 'Dunedin' had to be sold out of the family in February 1997, it is a fitting tribute to Jean that it is now restored and maintained by the local purchasers, Max and Ollie Archbold, under the name 'Garden in a Valley', and opened to the public at weekends.

Jean's knowledge of botany and Australian native plants developed apace after she met the noted amateur botanist H.B. Williamson at the FNCV wildflower show in 1922, when she was only 16 years old. Struck by her keeness, Williamson offered to help and in *The Victorian Naturalist* 97: 116 (1980) Jean wrote how '... for the next ten years he identified plants for me almost every week and introduced me to Mueller's *Key*, which I slowly learned to use.'

Jean joined the Field Naturalists Club of Victoria as a country member in December 1923. She soon became a frequent contributor of articles to *The Victorian Naturalist*, contributing a total of 128 from 1925 onwards over a span of fifty-six years. Most of these have either birds or plants as their subject, but a smattering of titles encompassed other topics such as local areas, spiders, tree-frogs, and mammals. Particularly notable is a contribution of 43 articles on *Australian Wattles* which appeared during 1959 to 1964. Each article demonstrates Jean's 'plain English' ability in descriptions and her own enjoyment and capacity in enlivening text with the feeling she held for her subject. Short notes which help to bring each plant delightfully to the reader's eye follow each description. For example, for *Acacia alpina* she wrote (*Vic. Nat.* 79: 65; 1962) '...On the few high mountains where alone it grows ... it looks completely and cheerfully at home', and for *Acacia glandulicarpa* (*Vic. Nat.* 79: 166; 1962) 'the blossom is so abundant

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that whole bushes look golden, like gay clouds along the dry roadsides'. Her final contribution to *The Victorian Naturalist* was an important historical article titled *Botanists and the FNCV - the first 30 years*. (*Vic. Nat.* 97:114-120; 1980).

When field naturalist's clubs were formed in Sale, Bairnsdale and the Latrobe Valley, they increased the opportunities for participation with local naturalists. Jean played a key role in the establishment of the Latrobe Valley Field Naturalists Club (first known as the Gippsland F.N.C.) in 1960, and was a founding member of it. She became a valued speaker, excursion leader, and mentor, and her involvement with this Club from its inception onwards was greatly instrumental in its development and growth. She was also a sometime lecturer at the Mt Beauty summer schools run by the Council of Adult Education. Although she had no car, offers of transport were readily forthcoming and she travelled widely within Australia. She was a prolific correspondent with her many contacts, felt keenly the need for conservation of natural areas, and was active in the preparation of conservation submissions to government authorities. As a practical measure for conservation, she donated land at Tyers for the first wildflower sanctuary established, in 1936, by the Native Plants Preservation Society of Victoria.

Jean formed her own reference herbarium of plants collected both locally and on her travels in all States. She shared her knowledge with both amateurs and professionals alike and any plant which appeared unusual to her discerning eye was sent to the National Herbarium of Victoria for assessment. Many of her collections are lodged there permanently. She herself was a frequent visitor to the National Herbarium, working through the collections as she compiled information for her botanical writings, and never arriving without a boiled fruit cake or similar offering to add to the staff tea table.

Writing was essential to Jean, who revelled in it. Her many contributions to *The Victorian Naturalist* have already been mentioned. She wrote gardening articles for *The Australian Garden Lover* from 1926-1976 under the name of 'Correa', for *Your Garden* for some years from 1954 and more latterly, from 1985-1992, for *The Age* newspaper, Melbourne. Those which appeared in the *Garden Lover* between August 1943 and June 1946 were republished as the book *A Garden Lover's Journal* in 1989, each telling joyfully of garden happenings at 'Dunedin' and of the country life around. The full story of 'Dunedin' is beautifully told in Jean's book *Garden in a Valley*. First published in 1939, it was republished in 1985 to the delight of many.

Undoubtedly Jean's landmark botanical publication appeared in 1950, when her *Wildflowers of Victoria* first came off the press from Colorgravure Publications, Melbourne. With short, simple-language descriptions of approximately 1000 species and 175 close-up, black and white photographs, it filled a great void for naturalists. The earlier work of E.E. Pescott, *Native Flowers of Victoria* (1914), had become unobtainable and that of A.J. Ewart, *Flora of Victoria* (1931), was rare and expensive. In addition, neither of these works had the same easy-to-use text and illustrations of Jean's volume, which was published in two further editions in 1955 and 1967 before being superceded by her greatly expanded and equally popular *Field Guide to the Wild Flowers of South-East Australia* (1977).

Jean Galbraith was elected a foundation life member of the Society for Growing Australian Plants at its formation in 1957 and was also honoured with life membership of the Victorian National Parks Association, the Native Plants Preservation Society, and the Latrobe Valley Field Naturalists Club. In April 1959 she was elected an honorary life member of the FNCV and in 1970 she was awarded the Australian Natural History Medallion for having conveyed 'interest in natural history and conservation to the general community, and stimulated people to a greater awareness of our natural heritage'. She was only the fourth woman to receive this award since its inception in 1939. Her alertness has been responsible for the discovery of new plant species and of extensions of the known range of rarer ones. Two species of plants have been named after her, namely *Dampiera galbraithiana* (*Telopea* 3: 204; 1988) and *Boronia gal-*

braithiae (*Muelleria* 8: 24; 1993). In describing the latter species the author acknowledged Jean with this tribute: '... doyenne of Victorian botanists, ... whose collections and writings have contributed much to our knowledge of flora of the Gippsland region'.

Much more could be written on Jean Galbraith the person, her life, and her contribution to others. I treasure the memories I have of her and feel very privileged to have known such a unique and selfless person. Warm and friendly, joyful in her Christian faith, generous, cheerful, compassionate and caring, yet ever-modest, she had a remarkable and endearing personality which will not be forgotten by all those who knew her.

Further Reading

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Jean Galbraith, surrounded by the flowers she loved so much, in her garden at 'Dunedin' (the *Garden in a Valley*). Photo kindly supplied by Ian Hyndman, Beechworth.

A Rich and Diverse Fauna: the History of the Australian National Insect Collection 1926 - 1991

Murray S. Upton

Publisher: *CSIRO Publishing, Collingwood, Victoria, 1997. xx + 385 pp. RRP $59.95*

From its inception, CSIRO's Division of Entomology has concentrated on agricultural problems and pest species; its first two projects involved cattle ticks and termites. It is a consequence of such applied research that a large collection of insects is accumulated, bringing with it a strong demand for taxonomic work. As it is now called, the Australian National Insect Collection (ANIC) is housed within the Division of Entomology and comprises about eight million specimens. This book tells the story of its first 65 years but, in spite of its subtitle, it imbeds the story of ANIC within the story of the Division, mirroring real life. It was not until 1962 that the name ANIC was gazetted and it took until 1980 before it moved into a dedicated building.

The first three chapters describe the inception of CSIR; its first Chief Entomologist, the brilliant but temperamental R.J. Tillyard; and the establishment of the entomological laboratory in Canberra. Thereafter the author arranges the chapters, not chronologically, but by topic and this can lead to some repetition. For review perhaps it is best to group the chapters into 'collecting', 'curating', 'taxonomy' and 'staff'.

Early 'collecting' is covered in chapter 6, with chapter 7 being devoted to Bill Brandt's heroic efforts in Papua New Guinea. Chapter 12 details the collecting expeditions since 1960. Each trip lists the staff involved, the route taken, the hardships encountered and, occasionally, some of the important specimens found. 'Curating' in a very general sense starts in chapter 8 when the laboratory was set up, a curator appointed, policies established and the detail of storage problems overcome. Chapter 9 emphasises the debt which the collection owes to gifts from both amateur and professional collectors over the years. Absolute numbers are astounding with donations of tens of thousands of specimens from individuals. Some were immaculately preserved while others were in poor array but containing valuable type specimens. This is the chapter that contains the stories of theft and mislaying of loans. Numerous departmental reviews, international pressures and interstate rivalries fill chapter 10, culminating in the recognition of ANIC and its place within CSIRO. Chapter 14 produces the new building and moves the collection into it.

Taxonomy is intimately connected with applied research and the housing and use of the collection. There are examples in this book of biological control programs which did not work, or were not necessary, because the target pest was incorrectly identified. Chapter 5 contains lots of early taxonomic research projects while those undertaken after about 1961 are detailed in chapter 13. Also included in this chapter are the publication of CSIRO journals and the monumental *Insects of Australia*. A lengthy discussion of the debate concerning the resting place for holotypes takes up all of chapter 15. In the context of the whole history of the Division and the Collection it probably takes too much space but the author's personal involvement is probably the reason for the bias. Finally, 'staffing' matters are covered in chapters 4 and 11, with the end of World War 2 marking the separation. Comings and goings of taxonomists and major events are faithfully recorded.

Between each chapter, throughout the book, are valuable archival photographs of personnel and places. Ten appendices detail staff, donated collections, standing orders, grants, publications and surveys. A comprehensive bibliography is included.

This is an important history to have been written and, as it was the author who gathered and systematised the ANIC Archives during his term as curator and manager of the collection, he was probably best suited to produce it. Nevertheless, some of his biases show. It is not difficult to see his contributions to ANIC and CSIRO were in

the leading of field trips, manufacture of unusual equipment, and the minutiae of curation techniques. Close reading will reveal his subtle but political comment on the vicissitudes of both Collection and Division. Three last comments on style: the book does demonstrate a curator's mentality; a reluctance to throw out any item (e.g. the travel allowance for the use of a member's own bicycle was 2½d per mile in 1930). Secondly, the first time a new player is introduced a potted biography of qualifications and prior experience is included. Perhaps they would be better included as another appendix as it does break the flow of reading. Finally, inclusion of an item in the index seems to work by the rule that it must be a direct reference to the CSIRO. Peripheral people and institutions miss out.

If you have any interest in Australia's entomological history then you should read this book, all the famous names are there and their struggles (against bureaucracy and funding cuts) and triumphs are repeated periodically. It might be of some comfort to know that current difficulties are not unique, and the fit tend to survive. The book has received a Whitley Award in the history of Australian zoology category.

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Endangered Ecosystem Series

Publisher: *Victorian National Parks Association, 10 Parliament Place, East Melbourne, Victoria 3002*
RRP $10.00 each or $24.00 full set (postage included).

Looking after Native Grasslands and Grassy Woodlands

It is not often as a teacher you can pick up a kit and get all the information you would need to prepare a teaching unit. This kit satisfies that requirement. As a primary teacher I find that this kit would satisfy my learning needs to guide students through the investigative process of establishing a sound basis of grasslands education. The action section, 'What You Can Do' is a particularly valuable resource. Many documents suggest to take action but few give practical ideas of how to do this. The action activities in this document are reasonably simple to do and are readily available for most teaching situations. The Native Grassland Site Visit Sheet would be difficult for most younger students. A teacher could easily adapt the ideas however, and produce a sheet suitable for their students. The site visit information brochures included in the kit are an excellent excursion resource and relevant information could be rewritten to suit younger students.

The kit itself would be an excellent resource for levels 5-7 secondary school studies in SOSE and Science key learning areas. The plant lists are an excellent basis for classification activities and would lend themselves to excursion activities such as writing dichotomous keys. The action section could be used as a stimulus for the formation of an environmental club practising grassland conservation, or as a unit of work concentrating on grasslands.

VCE students would find this kit an excellent resource in the biology, environmental studies and geography areas. The information is excellent and the Contact and Resources list invaluable as a resource for further research.

As is, the kit could serve as an excellent resource document for student research and would be great addition to any school or home library. I recommend this kit to anyone who is involved in, or is considering grasslands as a teaching unit. It has excellent information, great action ideas and what's more doesn't take an eon to read.

Looking after Marine and Coastal Areas

This kit is one of the most concise documents I have read on the state of Marine Ecology in Victoria. At times it is rather depressing. As a resource document it would be excellent for teachers or older students studying the marine area. For VCE it would be a valuable starting point for research. The contacts and reference section is excellent.

As a teacher I would use this kit more as a resource for myself rather than using it as a kit for students. While the information is excellent and students need know the facts, I feel some parts of the document are all 'doom and gloom' and would be better interpreted by educators. Students need to be empowered to act, not to feel action is a lost cause. If not interpreted properly some students may only see the negatives of this document.

I found information sheets 1 and 2 particularly informative. The concise descriptions of the terms and the types of habitats were simply written and easily understood. These would be an excellent starting point for any marine study.

Unfortunately, unlike the other kits in this series, the Marine kit did not include a site visit sheet. These sheets may not always be suitable for all levels of students but serve as a guide for educators to produce their own sheet. The information in the document and the site visit brochures are sufficient for teachers to produce their own sheets however.

I would recommend this kit as a valuable resource for all teachers and VCE students and it would be a suitable resource to have in the teachers' resource section in any library.

Looking after Box and Ironbark Forests and Woodlands

Did you know that if there are enough trees to form a canopy that shades 30% or more of the ground it is a forest. If the area is less than 30% shade, the plant community is called a woodland? This fact and many more you will read in the Box and Ironbark Information Kit. Written in a similar manner to the Grasslands and the Marine and Coastal Kits, this I feel is an essential resource to any school library. Teachers from Prep to VCE would find this kit useful. A particularly interesting section I feel for older students was Information Sheet 9. This section covered some of the government legislation involved in the Box and Ironbark Forests. While the information was minimal, it gives a good overview of some of the legislation involved in conservation processes in Victoria.

I found that I read this document with bird and flora identification books beside me. This made Sections 3 and 5 far more meaningful. Even though there is a reference list in the document I would suggest a list of readily available guides to flora and fauna in Victoria would be beneficial and should be used along with the kit.

The Box-Ironbark Site Visit Sheet is extremely helpful and could be used as an excursion guide for any teacher. The information sheets for the four park areas are excellent resources and could be utilised by teachers in many ways.

My immediate reaction to this kit was one of I don't know enough about these areas and need to do some more research, visiting and teaching about these limited and threatened areas of Victoria. For this reason, plus the fact that this, like the other kits in this series is excellent, I would recommend that it be purchased as an important resource in any teachers and school library.

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Flora and Fauna Guarantee Act 1988

The following Flora and Fauna Guarantee Scientific Advisory Committee Recommendation Reports have been received. The number following each listing is the nomination number.

Final Recommendations Reports

Supported for listing on Schedule 2:

Flora

Daisy, Yellow-tongue *Brachyscome chrysoglossa* – No. 449

Fauna

Bittern, Black *Ixobrychus flavicollis australis* – No. 450

Bittern, Little *Ixobrychus minutus* – No. 439

Crake, Baillon's *Porzana pusilla* – No. 447

Kite, Square-tailed *Lophoictinia isura* – No. 444

Rail, Lewin's *Dryolimnas pectoralis* – No. 446

Shark, Great White *Carcharodon carcharias* – No. 419

Tern, Caspian *Sterna caspia* – No. 443

Tern, Gull-billed *Sterna nilotica* – No. 438

Communities

Devonian Limestone Pomaderris Shrubland Community – No. 429

Grey Box - Buloke Grassy Woodland Community – No. 434

Limestone Grassy Woodland Community – No. 428

Semi-arid Herbaceous Pine Woodland Community – No. 432

Semi-arid Herbaceous Pine-Buloke Woodland Community – No. 433

Semi-arid Northwest Plains Buloke Grassy Woodland Community – No. 431

Semi-arid Shrubby Pine - Buloke Woodland – No. 430

Not supported for listing:

Gum, Yellow *Eucalyptus leucoxylon* subsp *connata* – No. 448 (significance of threats to the survival of the species not sufficiently demonstrated)

Preliminary Recommendations Reports

Supported for listing on Schedule 2:

Flora

Daisy, Dookie *Brachyscome gracilis* subsp. *gracilis* – No. 418

Donkey-orchid *Diuris tricolor* – No. 457

Duck-orchid, Grampians *Caleana* sp. aff. *nigrita* – No. 456

Greenhood, Robust *Pterostylis valida* – No. 458

Leek-orchid, Fragrant *Prasophyllum suaveolens* – No. 451

Liverwort *Pseudocephalozia paludicola* – No. 462

Spider-orchid, Dwarf *Caladenia pumila* – No. 455

Spider-orchid, Short *Caladenia brachyscapa* – No. 454

Sun-orchid, Basalt *Thelymitra gregaria* – No. 463

Sun-orchid, Winter *Thelymitra hiemalis* – No. 464

Swainson-pea, Downy *Swainsona swainsonioides* – No. 452

Water-shield *Brasenia schreberi* – No. 437

Fauna

Albatross, Sooty *Phoebetria fusca* – No. 442

Shark, Grey Nurse *Carcharias taurus* – No. 420

Communities

Coastal Moonah (*Melaleuca lanceolata* subsp. *lanceolata*) Woodland Community – No. 460

Lowland Riverine Fish Community of the southern Murray-Darling Basin – No. 459

Not supported for listing:

Fauna

Albatross, Black-browed *Diomedea melanophrys* – No. 441 (Threatening process occurs in oceanic waters beyond Victorian jurisdiction)

Albatross, Shy *Diomedea cauta* – No. 440 (Threatening process occurs in oceanic waters beyond Victorian jurisdiction)

Albatross, Wandering *Diomedea exulans* – No. 423 (Threatening process occurs in oceanic waters beyond Victorian jurisdiction)

Items considered invalid for listing:

Flora

Swainson-pea, Red *Swainsona plagiotropis* – No. 139 (Already listed on Schedule 2, No. 109)

Fauna

Frog, Giant Burrowing *Heleioporus*

australiacus – No. 241 (Already listed on Schedule 2, No. 114)

Invalid Nomination

Promotion and protection of environmental weeds – No. 445 (Subject considered to be covered by The Invasion of Native Vegetation by Environmental Weeds Schedule 3, No. 360)

Preliminary Recommendation Reports
Supported for listing on Schedule 3:
Potentially Threatening Processes

Human activity which results in artificially elevated or epidemic levels of Myrtle Wilt within *Nothofagus*-dominated Cool Temperate Rainforest – No. 453

Incidental catch (or by-catch) of seabirds during longline fishing operations – No. 424

Other Documents

A list of flora (including communities) protected under the *Flora and Fauna Guarantee Act* 1988.

Schedule 2 – list of taxa and communities of flora or fauna which are threatened.

Schedule 3 – list of potentially threatening processes.

An index of items nominated for listing that have been considered by the Scientific Advisory Committee and the status of the nomination.

Items added to schedules of the *Flora and Fauna Guarantee Act* 1988.

Copies of all FFG documents are held in the FNCV library.

The Field Naturalists Club of Victoria Inc.

Reg No A0033611X

Established 1880

In which is incorporated the Microscopical Society of Victoria

OBJECTIVES: ***To stimulate interest in natural history and to preserve and protect Australian flora and fauna.***

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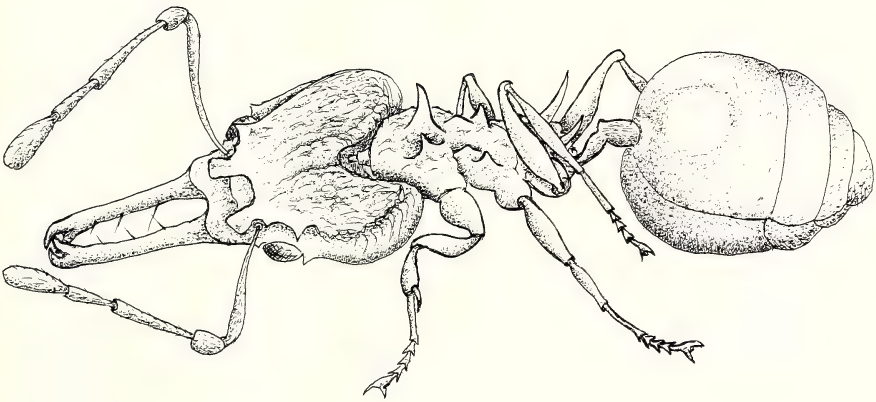

Published by The Field Naturalists Club of Victoria since 1884

A Bizarre Ant

A most unusual-looking ant was collected at Wilsons Promontory during the research weekend in October 1998. It was found in one of the traps set in the burnt heath site (38°54'21" S, 146°21'06" E). The distinctive features of this moderately-sized (c 5 mm), rust-coloured ant include: the form of the mandibles (parallel sided and very elongate), the spines and other protuberances on the trunk, and the heart-shaped head with strongly developed occipital lobes. The antennae are also unusual in that they only have five segments instead of the usual 11 or 12. Erich Sacco has drawn the specimen (front cover of this issue) which illustrates these characteristics.

The ant keyed out to the genus *Orectognathus* in the sub-family Myrmicinae. Additional information indicated that only one species of this genus was known from Victoria – *O. clarki* (Andersen 1991).

While the appearance of this ant is bizarre, its feeding habits are remarkable. The species feeds on Springtails (Collembola) which it hunts with its mandibles wide open. Sensory hairs on the inner part of the mandibles are triggered when they touch the prey and the jaws close on the Collembola (Brown 1953). The strike is, of necessity, extremely rapid since the escape response of a Springtail species has been measured at 4 milliseconds (four thousandths of a second) (Hölldobler and Wilson 1994). If the Springtails preyed on by *O. clarki* behave in a similar way, then this ant has to sense its prey and close its jaws within this time – speed indeed!

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Hölldobler, B. and Wilson, E.O. (1994). 'Journey to the Ants'. (Harvard University Press: Cambridge, Massachusetts, USA).

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Corrigendum

The editor has received correspondence pointing out the following misdetermination which should be corrected.

The determination of the liverwort referred to in 'The Biogeography of *Pseudocephalozia paludicola* R.M. Schuster; an Endemic Australian Liverwort' by Jon Sago, (*The Victorian Naturalist* **115** (3), 1998, 84-86) is incorrect. The liverwort has now been assigned as *Lepidozia laevifolia*. Also, please correct the perianth measurement in Para. 1, p. 84 of the article to 2 x 0.25 mm.

The drawing on p. 85 is of *Pseudocephalozia paludicola* R.M. Schuster, but the magnifications are incorrect. The correct magnifications for the drawing of the leaf and underleaf are x100.

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Cover: A bizarre ant, *Orectognathus clarki*. This ant is about 5 mm long. (See Naturalist Note on p. 82.) Drawing by Erich Sacco.

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Effect of Fire Frequency on Plant Composition at the Laverton North Grassland Reserve, Victoria

Ian D. Lunt[1] and John W. Morgan[2]

Abstract

The plant composition of two adjacent zones with different fire histories was documented at the Laverton North Grassland Reserve, in western Melbourne. One area remained unburnt for 17 years, from 1978 until 1995. The other zone was burnt six times during this period. Both zones were burnt 20 months before sampling in November 1996. The two zones were superficially similar in 1978, but differed substantially in 1996. In 1996, the rarely burnt zone was dominated by exotic species (49% cover c.f. 40% native cover), whereas the frequently burnt zone was dominated by native species (72% cover) with just 7% exotic cover.

Nearly half of the species recorded (22 species) differed significantly in cover between the two fire zones. The largest differences were for the exotic Cat's Ear *Hypochoeris radicata* (33% mean cover in the rarely burnt zone c.f. 1% in the frequently burnt zone) and Kangaroo Grass *Themeda triandra* (22% in the rarely burnt zone c.f. 63% in the frequently burnt zone). The density of live Kangaroo Grass tussocks in the rarely burnt area was only 30% of that in the frequently burnt zone. These differences are assumed to reflect different fire histories rather than underlying environmental patterns. The long-term absence of burning has caused the death of many Kangaroo Grass tussocks and promoted many perennial exotic weeds. The need for frequent biomass removal in productive Kangaroo Grass grasslands is emphasised. (*The Victorian Naturalist* **116** (3), 1999, pp. 84-90).

Introduction

It has long been known that extended intervals without grass removal (by burning, light grazing or slashing) can lead to substantial losses of native plant diversity in many grasslands dominated by Kangaroo Grass *Themeda triandra* in south-eastern Australia (Stuwe and Parsons 1977; Scarlett and Parsons 1982, 1990). For this reason, most grassland management plans incorporate the need for frequent biomass reduction (e.g. Craigie and Stuwe 1992; DCE 1992). However, despite the widespread acceptance of this recommendation, few studies have documented the long-term outcomes of failing to regularly remove grass biomass.

The Laverton North Grassland Reserve, 20 km southwest of Melbourne (37°51'S, 144°48'E) has been managed for grassland conservation since 1978. Grazing stock have been excluded during this period and the reserve has been intermittently burnt. From 1978 to 1995, all disturbances (including fire) were intentionally excluded from one small, triangular area of about 2.5 ha, which acted as a 'control' plot against which the effects of burning could be assessed. There were no obvious differences between the control and adjacent areas initially (Bob Parsons, *pers. comm.*, July 1998). The control area remained unburnt for 17 years, until it and surrounding areas were burnt in March 1995.

Despite its small size and the lack of replicate controls, the long-unburnt area at Laverton provides a valuable opportunity to document the impacts of the prolonged exclusion of burning and grazing, especially given the existence of detailed knowledge about the management history of the plot and surrounding areas. In this paper, we describe and contrast the plant composition of the long-unburnt area and an adjacent area which was burnt six times during the past 17 years, and we discuss the relevance of these results for grassland conservation.

Methods

Two adjacent areas within the Laverton North reserve were examined. The 'frequently burnt' zone was burnt six times after 1978: in March 1980, March 1983, March 1985, February 1987, 1990 (month unknown) and March 1995 (McDougall 1989; J. Morgan *unpubl. data*). By contrast, the rarely burnt zone was burnt only once during this period, in March 1995, 17

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years after reservation. Both zones were sampled in November 1996, 20 months after the most recent fire.

Five, parallel, 50 m long transects were located 40-50 m apart in the frequently burnt zone, and five in the infrequently burnt zone. Transects in the two zones were approximately 150 m apart. A 1 m^2 quadrat was sampled every 5 m along each 50 m transect, giving 100 quadrats in all (50 in the frequently burnt zone and 50 in the rarely burnt zone). In each quadrat, all vascular plant species were identified and the cover of each species was visually estimated to the nearest 5%. For data analysis, species with less than 1% cover were assigned a cover value of 0.5%.

To assess whether the vegetation composition of the two zones was markedly different, the quadrat data were classified using the PATN analysis package (Belbin 1994). In this program, quadrats with the same species are grouped together, whilst those with different species are grouped separately. Cover data were first range standardised, and the Bray-Curtis association index was calculated. The flexible unweighted paired group arithmetic average (UPGMA) procedure was used to classify data, with default β = -0.1 (Belbin 1994). To identify species and species groups which occurred more frequently in either zone, mean percentage cover was compared for each species and group between the two zones using the non-parametric Mann-Whitney U-test (Sokal and Rohlf 1981).

To determine how fire management affected tussock attributes of the dominant grass, the number of live tussocks, live tillers and inflorescences of Kangaroo Grass (scientific names are given in Appendix 1) were counted in five 0.25 m^2 plots randomly placed in each zone on 23 November 1996. Total plant biomass was recorded by harvesting all plant matter to ground level in six 0.25 m^2 quadrats, and drying for 72 hrs at 80°C. Significant differences between these attributes were investigated using the Mann-Whitney U-test. All plant names follow Ross (1996), and asterisks before the scientific name indicate exotic species.

Results

The classification analysis clearly separated all frequently burnt quadrats from all rarely burnt quadrats, indicating that the vegetation of both zones was substantially different. The percentage cover of native and exotic species differed between the two zones (Table 1). The frequently burnt zone was dominated by native species (72% cover) with relatively little cover of exotics (7%), whereas the rarely burnt zone was dominated by exotic species (49% cover) with just 40% cover of native species (Table 1).

Almost half of the species recorded (46%, 22 species) occurred at significantly greater cover in one of the two zones (at $P < 0.01$; Appendix 1). Only one species, Kangaroo Grass, exceeded 5% mean cover in the frequently burnt zone, where it averaged 63% cover. By contrast, five species exceeded 5% mean cover in the rarely burnt zone: Cat's Ear **Hypochoeris radicata*, Kangaroo Grass, Rigid Panic *Homopholis proluta*, Squirrel-tail Fescue **Vulpia bromoides* and Spear-grasses *Stipa* species. The exotic Cat's Ear dominated the rarely burnt area with a mean cover of 33%, but reached only 1% mean cover in the frequently burnt zone. Despite dramatic differences between the two fire zones in the mean *cover* of different species, the mean *number* of species in each quadrat (i.e. species richness) was similar in both zones (Table 1). On average, 10.5 species occurred in each quadrat in the rarely burnt area, compared to 9.6 in the frequently burnt area; although small, this difference was statistically significant ($P < 0.05$; Table 1).

Surprisingly, given the substantial differences in management history, there was no significant difference ($P > 0.05$) between the two zones in the species richness or cover of all annual species when pooled together. Furthermore, when assessed individually, most annual species occurred at similar frequencies in both zones. Only four species – Mediterranean Brome **Bromus hordeaceus*, Oats **Avena* sp., Lesser Quaking-grass **Briza minor* and Subterraneum Clover **Trifolium subterraneum* – had a significantly greater cover in either zone in 1996, and all were more

Table 1. Mean species richness and cover of native and exotic species in frequently burnt and rarely burnt zones at Laverton North in November 1996. Significance levels using the Mann-Whitney U-test: NS = not significant ($P > 0.05$); * = $P < 0.05$; *** = $P < 0.001$.

Attribute	Frequently burnt	Rarely burnt	Significance (*P* value)
		Mean % cover	
Native species	72.0	40.5	***
Exotic species	6.6	49.0	***
		Mean species richness	
Number of species	9.6	10.5	*
Native species	3.3	3.9	*
Exotic species	6.3	6.6	NS

abundant in the rarely burnt zone (Appendix 1).

Only one geophyte was recorded, Common Onion-grass **Romulea rosea*. This species occurred in all frequently burnt quadrats (mean cover 0.5%), but none of the unburnt plots. Whilst significantly more forb species were recorded from each quadrat in the frequently burnt zone (5.4 c.f. 4.0, $P < 0.0001$), forb cover was significantly greater in the rarely burnt zone (37% c.f. 6%, $P < 0.0001$), owing to the abundance of Cat's Ear.

Quadrats in the rarely burnt zone had significantly fewer Kangaroo Grass tussocks and tillers than those in the frequently burnt zone (Table 2). However, there was no significant difference between the zones in the number of inflorescences or tillers produced per tussock ($P > 0.05$). Mean biomass 20 months after burning was substantially greater in the frequently burnt zone, but this difference was not significant ($P = 0.0549$); however the *P* value is close to 0.05 and suggests that a Type I error might be likely, and that significant difference may have been reported had more samples been collected. Many dead Kangaroo Grass tussocks and tillers occurred in the rarely burnt area, indicating substantial Kangaroo Grass mortality in the past.

Discussion

The frequently burnt and rarely burnt areas at Laverton North Grassland Reserve now have very different plant compositions, despite their superficial similarity at the time of reservation in 1978. The most obvious differences are the abundance of exotic species and the decline of Kangaroo Grass in the area which remained unburnt for 17 years.

Statistically, this sampling design is termed 'pseudoreplicated' (Hurlbert 1984); whilst the samples (quadrats) were replicated, the two treatments (fire zones) were unreplicated (i.e. there was only one zone for each fire type, rather than replicates of both treatments). This problem plagues many observational and experimental studies in ecology (e.g. Wahren *et al.* 1994). This means that, whilst significant differences in plant composition between the zones can be formally demonstrated, the reasons for these differences cannot be formally identified from the data gathered. Since only one unburnt area exists, it is possible that the differences between the burnt and unburnt zones were not necessarily due to burning history, but could perhaps be due to underlying differences in soil type or initial plant composition. Such a problem highlights the value of including more than one 'control' site in a reserve, to increase the confidence that any differences between the control and other areas were due to different management treatments, rather than to intrinsic site factors.

Notwithstanding this statistical caveat, we are confident that the differences observed are primarily due to different burning histories rather than to underlying site factors. Firstly, there are no obvious differences in topography or soils between the two areas. Secondly, when the 'control' area was first established in the 1970s, there were no obvious differences between the control and adjacent areas (Bob Parsons and Dale Tonkinson, *pers. comms*, July 1998). Thirdly, the boundary between the two zones is obvious, sharp,

Table 2. Comparison of mean tussock attributes of the dominant grass, *Themeda triandra*, between the two fire zones in November 1996, 20 months after burning. Significance levels using the Mann-Whitney U-test: NS = not significant ($P > 0.05$); * = $P < 0.05$; ** = $P < 0.01$.

Attribute	Frequently burnt	Rarely burnt	Significance (P value)
Biomass (kg/ha)	4640	3490	NS
No. tussocks / 0.25m^2	11.8	3.6	**
No. live tillers / 0.25m^2	406	170	*
No. inflorescences / 0.25m^2	46	28	NS

triangular, and clearly marks the fire boundary between the two zones. The long-unburnt vegetation is now distinctively different from grassland vegetation throughout the rest of the Laverton North Reserve, even though soil and drainage conditions vary considerably in other areas of the reserve. Furthermore, the decline in Kangaroo Grass in the long-unburnt area follows a similar trend to that observed at the nearby Derrimut Reserve, where the poor Kangaroo Grass health was directly related to fire history (Lunt and Morgan 1999a; Morgan and Lunt 1999). Finally, the long-unburnt area at Laverton North has been observed by many grassland botanists during the past 20 years. All those we contacted had no doubt that fire management was likely to be the principal reason for the substantial differences in plant composition between the two zones (Keith McDougall, Bob Parsons, Steve Platt, Neville Scarlett, Dale Tonkinson, *pers. comms*, July 1998). For these reasons we are confident that, whatever minor differences in soils and initial plant composition might exist between the two areas, long-term differences in fire management are most likely to account for the patterns observed.

Kangaroo Grass mortality

The long-term absence of fire (and other disturbances) led to a substantial decline in the dominant Kangaroo Grass in the rarely burnt zone. There were many dead tussocks in this zone, and the density of live tussocks was only 30% of that in the frequently burnt zone. A similar decline of Kangaroo Grass in the absence of fire has also been found at the nearby Derrimut Grassland Reserve (Morgan and Lunt 1999). At Derrimut, dead grass from previous years' growth steadily accumulated until tussocks started to senesce after about 5 years and eventually died after about 10 years. The cause of death was assumed to be self-shading by old, dead leaves. Areas which had not been burnt for 11 years supported extensive swards of dead Kangaroo Grass, only 25% of which survived when tussocks were belatedly burnt (Morgan and Lunt 1999).

McDougall (1989) studied the long-unburnt zone at Laverton North in 1986 (8 years after the reserve was proclaimed), and documented the poor health of unburnt Kangaroo Grass tussocks at that time. Whilst McDougall (1989) described the small basal area and poor root development of unburnt plants, which were easily killed after trampling, he did not record any substantial mortality of Kangaroo Grass and this appears to have occurred since 1986. This mortality has major implications for future weed invasions, since areas where Kangaroo Grass has died are likely to be prone to invasion by exotic species such as Chilean Needle-grass **Nassella neesiana* (Lunt and Morgan 1999b). Elsewhere, we have suggested a simple method of assessing Kangaroo Grass health to help prevent such mortality occurring in other areas (Lunt and Morgan 1998).

Exotic species

A number of perennial exotic species – including Cat's Ear, Yorkshire Fog **Holcus lanatus*, Paspalum **Paspalum dilatatum*, Buck's-horn Plantain **Plantago coronopus* and Ribwort **Plantago lanceolata* – were abundant in the long-unburnt area in 1996, but were rare or absent in the frequently burnt zone (Appendix 1). All of these species have expanded considerably since McDougall's 1986 survey (McDougall 1989). For instance, Cat's Ear was recorded from just

1% of quadrats in the rarely burnt zone in 1986, compared to 100% in 1996. Similarly, Ribwort, Yorkshire Fog and Buck's-horn Plantain were not recorded from either zone in 1986, but occurred in 92%, 66% and 18% respectively of rarely burnt quadrats in 1996. These perennial weeds grow vigorously in rank, undisturbed vegetation, and their expansion is disturbing, since all are likely to be difficult to control.

By contrast, another group of exotic species (including the wind-blown daisies, Aster-weed **Aster subulatus*, Spear Thistle **Cirsium vulgare* and Ox-tongue **Helminthotheca echioides*) was more abundant in the frequently burnt zone than the rarely burnt area. These three species have increased in abundance since 1986 (McDougall 1989). The reason for this expansion is unknown but worthy of further investigation. Thus, whilst frequent burning did not prevent invasion of all exotic species, it did result in significantly less cover of exotic species than did fire exclusion.

Many species of exotic annual grasses and forbs are abundant at Laverton North (and in many other grassland remnants). Consequently, the impact of different fire regimes on this group of species is of some interest. Perhaps surprisingly, given the magnitude of the differences between the two zones, there was no significant difference between the two zones for most exotic annuals. The abundance of exotic annual species in both zones in 1996 (20 months after burning) demonstrates their potential to rapidly re-establish large populations from a persistent soil seed bank. Thus, long-term fire exclusion did not provide a suitable method for depleting these exotic species.

By contrast, long-term fire exclusion proved an extremely successful method of controlling the exotic geophyte, Common Onion-grass **Romulea rosea*. This species is abundant in many grassland remnants in south-eastern Australia (McDougall and Kirkpatrick 1994) and resprouts vigorously after fire (Lunt 1990). In 1996, Common Onion-grass was not recorded from a single quadrat in the rarely burnt zone, but was found in every quadrat in the frequently burnt zone. This decline has occurred since 1986, as McDougall (1989) recorded the species from 98% of frequently burnt quadrats and 89% of unburnt quadrats in 1986. Unfortunately, however, this small beneficial outcome was more than compensated for by the negative impacts of Kangaroo Grass death and the promotion of other perennial exotic weeds in the long-unburnt area.

Generality of results

This study has documented a number of adverse outcomes from long-term fire exclusion in a native grassland, including the decline of Kangaroo Grass and the promotion of vigorous, perennial exotic weeds. These findings support much of the grassland conservation literature (e.g. Stuwe and Parsons 1977; McDougall 1989; Lunt 1991) which has stressed the need for frequent biomass reduction (i.e. grass removal) to maintain grassland values. However, whilst earlier recommendations have focussed on potential losses of native plant diversity, these results show little change in native plant diversity, but instead show an expansion of perennial weeds and decline of the dominant Kangaroo Grass.

The failure to document major changes in native plant diversity probably reflects the landuse history of the Laverton North reserve. When the reserve was established in 1978, native plant diversity was low as a result of past stock grazing (many species occurred in the reserve, but few forbs were abundant). By contrast, studies which have recorded substantial losses of native plant diversity beneath dense grass have focussed on intact, diverse remnants (e.g. rail and road reserves) or more sensitive species (e.g. Scarlett and Parsons 1990; Morgan 1997). Presumably such losses may also have occurred at Laverton North had the area been diverse in the 1970s.

How relevant are these findings to other grasslands dominated by Kangaroo Grass? Since this study was conducted at one site only, it is difficult to generalise to other areas. However, we have observed similar processes in other Kangaroo Grass grasslands in western Victoria (e.g. Derrimut and Lake Goldsmith Wildlife Reserve), Gippsland (e.g. West Sale) and the ACT.

Conversely, grasslands exist in these and other regions with a diverse native flora and healthy swards of Kangaroo Grass, despite not being grazed or burnt for extended periods (e.g. McDougall and Kirkpatrick 1994, p. 61). Clearly, further work is required to better predict where such problems are likely to occur in the future. We would suspect however that Kangaroo Grass decline can potentially occur in many productive sites (of moderate rainfall and/or soil fertility) where Kangaroo Grass can grow vigorously to form a closed sward. Elsewhere, we would simply encourage managers to remain alert to the possibility of future grass mortality, and to assess grass health regularly (Lunt and Morgan 1998).

Whilst the lessons learnt from the long unburnt zone at Laverton North are negative ones, we do not wish to imply that the unburnt 'control' plot should never have been managed in this way. On the contrary. The long-unburnt zone has provided valuable lessons in a relatively small area. Hopefully these lessons will not have to be re-learnt elsewhere.

Acknowledgements

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Appendix 1. Percentage frequency and mean percentage cover of all plant species in the frequently burnt (freq. burnt) and rarely burnt zones of the Laverton North Grassland Reserve in November 1996. Asterisks before the scientific name denote exotic species. Differences in mean % cover were determined using Mann-Whitney U-tests. Values are highlighted where $P < 0.01$. Significance levels: NS = not significant ($P > 0.05$); * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$.

Species	**Common name**	**% frequency**		**Mean % cover**		
		Freq. burnt	**Rarely burnt**	**Freq. burnt**	**Rarely burnt**	**Signif. (*P* value)**
Acaena echinata	Sheep's Burr	0	2	0.00	0.01	NS
Agrostis aemula	Purplish Blown Grass	16	0	**1.84**	0.00	**
Agrostis avenacea	Common Blown Grass	60	66	4.92	1.29	NS
**Anagallis minima*	Chaffweed	4	2	0.02	0.01	NS
Asperula scoparia	Prickly Woodruff	2	0	0.01	0.00	NS
**Aster subulatus*	Aster-weed	94	36	**0.47**	0.18	***
**Avena* species	Oat	4	66	0.02	**0.33**	***
**Briza maxima*	Large Quaking-grass	6	0	0.04	0.00	NS
**Briza minor*	Lesser Quaking-grass	70	34	0.35	**0.46**	***
**Bromus hordeaceus*	Soft Brome	20	60	0.10	**0.31**	***
Carex breviculmis	Short-stem Sedge	4	52	0.02	**0.26**	***
**Centaurium tenuiflorum*	Branched Centaury	0	4	0.00	0.02	NS
**Cirsium vulgare*	Spear Thistle	86	40	**1.04**	0.02	***
Convolvulus erubescens	Pink Bindweed	4	44	0.11	**0.23**	***
**Conyza bonariensis*	Tall Fleabane	22	6	0.11	0.03	*
**Cynodon dactylon*	Couch	0	4	0.00	0.02	NS
**Cyperus tenellus*	Tiny Flat-sedge	2	4	0.01	0.51	NS
Danthonia species	Wallaby-grasses	8	10	0.04	0.07	NS
Deyeuxia quadriseta	Reed Bent-grass	4	10	0.02	0.14	NS
Dichelachne crinita	Long-hair Plume-grass	16	0	**0.08**	0.00	**
Elymus scabrus	Common Wheat-grass	2	0	0.01	0.00	NS
Epilobium billardierianum	Robust Willow-herb	38	0	**0.19**	0.00	***
Eryngium ovinum	Blue Devil	6	12	0.04	0.06	NS
**Euchiton* species	Cudweed	0	2	0.00	0.01	NS
**Gamochaeta purpurea*	Cudweed	2	0	0.01	0.00	NS
**Helminthotheca echioides*	Ox-tongue	48	2	**0.64**	0.01	***
**Holcus lanatus*	Yorkshire Fog	0	66	0.00	**3.10**	***
Homopholis proluta	Rigid Panic	0	20	0.00	**10.82**	***
**Hypochoeris radicata*	Cat's Ear	54	100	1.24	**33.41**	***
**Juncus capitatus*	Dwarf Rush	0	4	0.00	0.02	NS
**Leontodon taraxacoides*	Hairy Hawkbit	20	16	0.20	0.12	NS
**Lolium rigidum*	Wimmera Rye-grass	2	4	0.02	0.02	NS
Oxalis perennans	Grassland Wood-sorrel	4	6	0.02	0.03	NS
**Paspalum dilatatum*	Paspalum	0	8	0.00	1.32	*
Pimelea spinescens	Plains Rice-flower	2	2	0.01	0.01	NS
**Plantago coronopus*	Buck's-horn Plantain	0	18	0.00	**1.50**	**
**Plantago lanceolata*	Ribwort	0	92	0.00	**0.46**	***
**Romulea rosea*	Common Onion-grass	100	0	**0.50**	0.00	***
Schoenus apogon	Common Bog-sedge	4	0	0.02	0.00	NS
Senecio glomeratus	Annual Fireweed	2	4	0.01	0.02	NS
Senecio quadridentatus	Cotton Fireweed	54	10	**1.24**	0.05	***
**Sonchus asper*	Rough Sow-thistle	2	6	0.01	0.32	NS
Stipa species	Spear-grasses	2	48	0.01	**5.49**	***
Themeda triandra	Kangaroo Grass	98	100	**63.40**	22.07	***
**Tragopogon porrifolius*	Salsify	0	20	0.00	**0.10**	***
**Trifolium subterraneum*	Subterraneum Clover	0	14	0.00	**0.07**	**
**Vulpia bromoides*	Squirrel-tail Fescue	96	82	1.78	6.65	NS
**Vulpia myuros*	Rat's-tail Fescue	0	4	0.00	0.02	NS

The Beetle *Gondwanennebous minutissimus* Kaszab (Coleoptera: Archeocrypticidae) – a First Record for Victoria

A number of small beetles (<3 mm) that had been collected from pit lines in the Red Box *Eucalyptus polyanthemos* woodland at Glynns Reserve, Warrandyte, during the FNCV survey of the invertebrate fauna, could not be identified. The key used (Moore 1980) only works satisfactorily with beetles greater than 3 mm in length.

In some cases, there were large numbers of these small beetles, for example 143 were collected in January 1997, 114 in July 1997 and 47 in September 1997. Since non-identification would have made the overall results of the survey less meaningful, help was sought from Dr John F Lawrence (CSIRO Canberra, Division of Entomology) in identifying two particular groups that made up most of the unidentified specimens.

Dr Lawrence was very helpful, and named the two species of beetles which comprised most of the unidentified specimens as *Thalycrodes pulchrum* (Coleoptera: Nitidulidae) and a *Nargomorphus* sp. (Coleoptera: Leiodidae). Furthermore, he enthusiastically selected another minute beetle (brown, ca 2 mm), unidentified from the July sampling, which he identified as *Gondwanennebous minutissimus*. Dr Lawrence said that this beetle had been previously known only from New South Wales, ACT, South Australia and Western Australia (Lawrence 1994). Our specimen (Fig. 1) was, therefore, the first record from Victoria.

Details of the Glynns record: Date, 12–19 July 1997; Location, Warrandyte, Victoria 37°44'12" S, 145°11'42" E; Habitat, Red Box *Eucalyptus polyanthemos* woodland; Collecting method, pitfall traps; Collector, The Field Naturalists Club of Victoria.

The specimen has been lodged with the Museum of Victoria who also advise this is the first and only specimen from this family in their collections (A. Yen *pers. comm.*).

This note reinforces two important lessons – the need to retain and label all unidentified species within an order, and how easy it is to overlook important material through lack of knowledge and skill.

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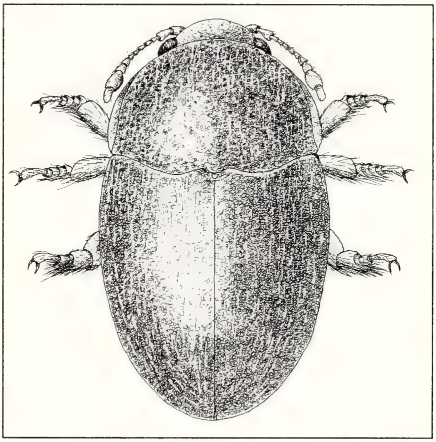

Fig. 1. *Gondwanennebous minutissimus* (about 2 mm). Drawing by Erich Sacco.

Thin-skinned Tectonics: its Application in Western Victoria

D.H. Taylor[1]

Abstract

Thin-skinned tectonics has become the standard framework for interpreting the crustal structure of Victoria. Steeply dipping structures visible at the surface are no longer viewed as extending downwards to great depths. Instead such structures are interpreted to have 'grown' or 'peeled off' from discrete levels in a crust composed of several stacked layers, the topmost being a 'thin-skin'. (*The Victorian Naturalist* **116** (3), 1999, pp. 92-96).

Introduction

This paper was written on invitation to explain the much used term thin-skinned tectonics, with examples from Victoria being used to illustrate the concept. Tectonics is the study of the structures in rocks and the broader geometrical architecture of the earth's crust which develops in response to imposed pressures. Geology is a young science and many of the accepted ideas about how structures develop when imposed pressures deform rocks are relatively recent. For example, theories explaining how rocks fold and develop cleavages weren't well documented until the 1960-70s, and compressional (stacking) and extensional (segmenting) faults were poorly understood until the late 1970s and early 1980s. The recent widespread acceptance and application of the concept of thin-skinned tectonics has grown out of these basic understandings of how rocks and the crust deform.

The new array of concepts has allowed a much more dynamic interpretation than previously - a paradigm shift. It is now accepted that large pieces of the crust may be transported around on accommodating structures such as weak or 'slippery' layers and stacked or emplaced upon other crustal pieces to form a composite crust of which the upper levels may be considered a 'thin-skin': hence the term 'thin-skinned tectonics'. The process being somewhat analogous to a carpet being pushed across and rucking up over a smooth floor.

The view that the deformed crust we see at a site today always represents the remains of strata once deposited close to that original site may also no longer hold true. The process of continental drift is now recognised as the mechanism by which masses of rock formed in one place on the earth's surface may be transported and amalgmated into another region which was previously far away, thus giving rise to 'exotic terranes' (e.g. Jones *et al.* 1983).

This burgeoning knowledge has revolutionised how we interpret the architecture of the earth's crust from the mapping of the 2-dimensional surface exposure. In the past, surface structures were extended to great depths into the underlying crust which was considered to be static and essentially deformed in place. This is the view expressed in the first comprehensive synthesis of the Geology of Victoria (Douglas and Ferguson 1976). Since then the concept of thin-skinned tectonics has been applied to Victoria (e.g. Fergusson *et al.* 1986) and incorporated into the revised synthesis of the Geology of Victoria (Douglas and Ferguson 1988). Since the revised geological synthesis was presented, widespread detailed and ongoing geological mapping of the state by the Geological Survey of Victoria (e.g. VandenBerg *et al.* 1992; Cayley and McDonald 1995; Taylor *et al.* 1996) and university investigations (e.g. Cox *et al.* 1991) has filled in much of the detail only addressed in principle in the revised synthesis (Fig. 1).

Western Victoria: an example of thin-skinned tectonics

In the first synthesis of the Geology of Victoria (Douglas and Ferguson 1976) the deformed piles of deep marine sediments that comprise most of western Victoria were viewed as different sedimentary basins (depositional troughs) separated by highs of volcanic rock (Fig. 2). The troughs contain many kilometres of sediments, thickened by folding, and cut by numerous faults. Across the goldfields of western Victoria much of the structure was

[1] Geological Survey of Victoria, P.O. Box 500, East Melbourne, Victoria 3002.

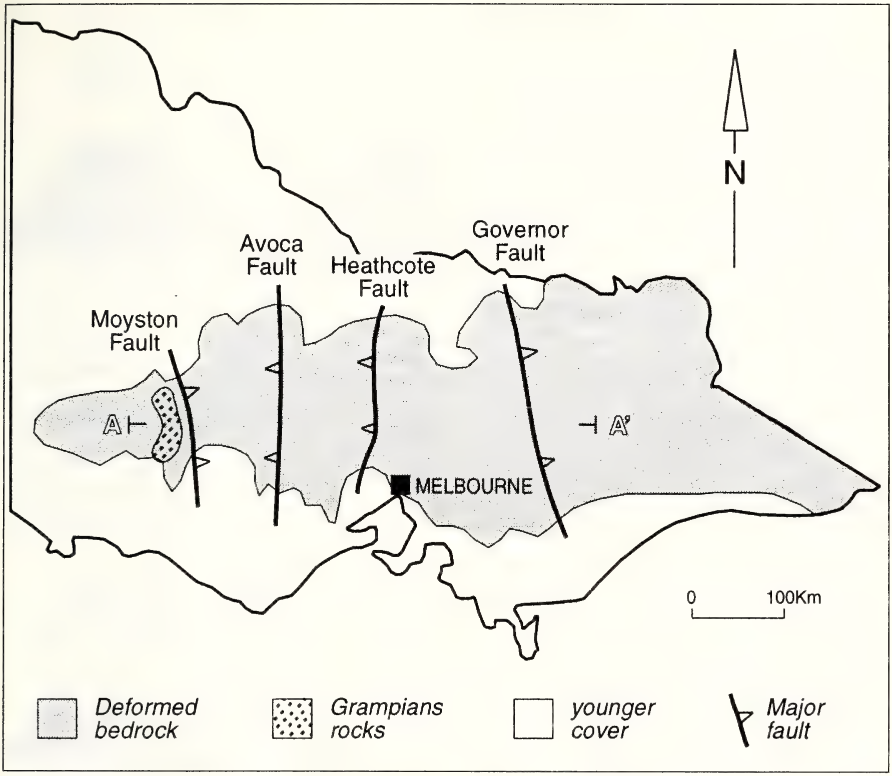

Fig. 1. Map of Victoria showing the position of the major faults across the west-central region and the position (A-A') of the section lines presented in Figs. 2, 3 and 4.

inferred from the distribution of graptolite fossils (small planktonic marine organisms whose diversification over time makes them useful for determining rock ages) which also provided an estimate of the offset across large faults (e.g. Harris and Thomas 1948). The extent and geometry of the faults below the surface were unknown but were viewed as extending sub-vertically to as deep as any cross-section could show. A synthesis of how the surficial rocks were deformed and what lay beneath them was beyond the scope of the geological knowledge of the time.

By the second edition of the Geology of Victoria (Douglas and Ferguson 1988) the ideas and mechanisms of thin-skinned tectonics had been applied to Victoria. Rather than being in-situ, separate sedimentary basins the deformed sediments were now interpreted as being parts of the same large ocean basin amalgamated along major faults (Fig. 3). Movement along these major faults transported the volcanic rocks, fragments of the original ocean floor underlying the sediments, to the surface. Thus the volcanic rocks are no longer viewed as ancient topographic highs separating many depositional troughs but as the deepest parts of one great big trough brought to the surface by faults!

The major faults continually expose the volcanic rocks, or the oldest sediments lying just above them. In the deformed rock pile these rocks generally now reside at mid-crustal levels of about 15 km. Since the faults are steep at the surface and keep bringing rocks to the surface from roughly the same crustal level they must flatten out and tap into this mid-crustal level which is called a detachment (Fig. 3). The flattening geometry of the faults is called a listric geometry and is supported by seismic imaging of the subsurface geometry of the

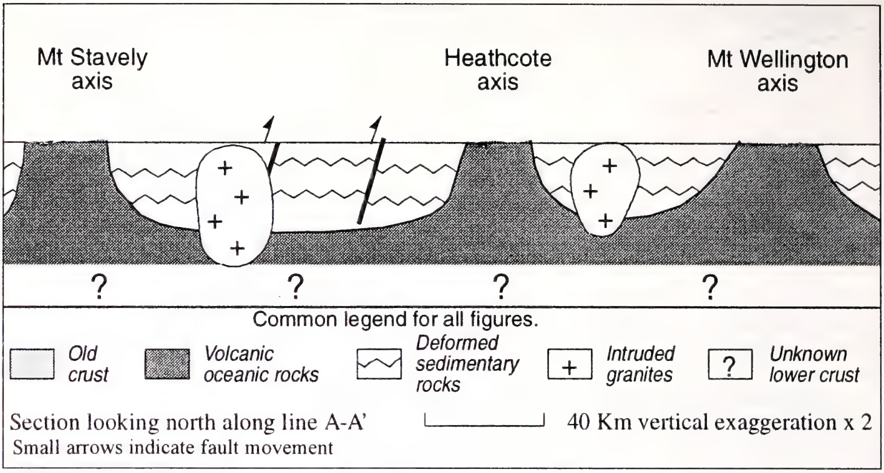

Fig. 2. Schematic cross-section of the crustal structure of western Victoria constructed from the first synthesis of Victorian geology. Note the unconstrained extension of surface structures to depth and the implication of in-situ deformation of all the exposed rocks. Note that the legend for Fig. 2 is a common legend for all Figures.

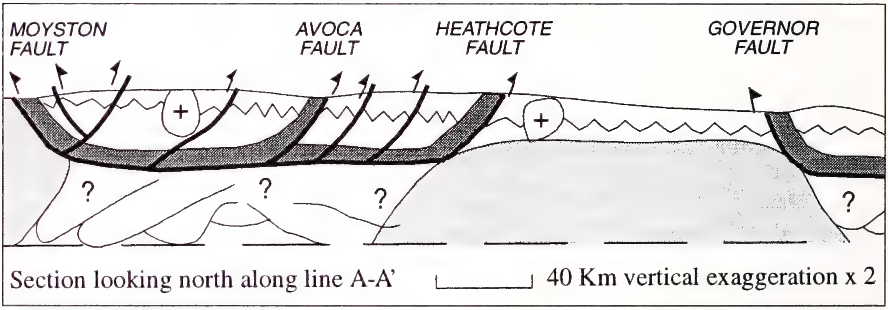

Fig. 3. Schematic cross-section of the thin-skinned tectonic interpretation of the crustal structure of western Victoria as presented in the second synthesis of Victorian geology and updated by more recent mapping. Note a top layer of folded and faulted sedimentary rocks above mid-crustal detachment faults in the underlying volcanics which are occasionally brought to the surface. The nature of the deeper crust is unknown.

Heathcote Fault Zone in which the major fault was shown to flatten at depth (Gray *et al.* 1991). Such major faults stack the stratigraphy and thus effectively shorten it, helping to accommodate the deformation imposed upon the rocks. In the sediments above the level of the mid-crustal detachment faults, the deformation is largely accommodated by the tight folds and cleavage visible in outcrops. How the shortening is accommodated below the level of the mid-crustal detachment faults is unknown but it was possibly thickened by a separate system of fault stacking.

Geological mapping in areas not complicated by strong deformation shows that the original ocean basin of western Victoria probably consisted of 3-5 km of sand-rich sediment deposited upon an ocean floor of volcanic crust that is known from modern settings to be about 6 km thick. Fossils and dating of radioactive isotopes show that this ocean basin existed from about 510 to 420 million years ago. Mapping of more deformed areas suggests significant thickening of these rocks during deformation by folds and fault stacking to form a crust about 30-40 km thick (e.g. Gray and Willman 1991). All this deformation was driven by plate tectonic forces which forced the ocean basin of western Victoria to be pushed onto the edge of the older

Australian rocks to the west. The age of this deformation is constrained between the depositional age of the rocks and the intrusion age of later granites to about 450-420 million years ago (VandenBerg 1976), a timing broadly confirmed by recent dating of minerals that grew during the deformation (Foster *et al.* 1998).

The Moyston Fault is the big fault which emplaced the oceanic basin of western Victoria against older rocks to the west (Cayley and Taylor 1998). This fault trends northwesterly through Moyston in western Victoria. West of the fault is the flat surface of the Dundas Tableland from which the Grampians Ranges protrude. To the east is the hilly country of the Western Victorian Uplands with the well developed Great Divide. Within this belt of rocks numerous faults splay up through the 'thin-skin' of folded sediments, with the biggest bringing the volcanic rocks from mid-crustal levels of about 15 km to the surface. These include the Avoca Fault which trends northerly between Maryborough and Avoca and the Heathcote Fault Zone trending northerly through Heathcote. Smaller faults which bring up sediments from just above the volcanics also occur in Victoria, with many being recognised by associated zones of more intense deformation caused by the fault movement, or by disruption to the distribution pattern of graptolite fossils. Goldfields such as Stawell often lie directly on such faults while other goldfields such as Bendigo and Ballarat occur in close proximity. It is generally accepted that the faults acted as conduits for gold-rich fluids generated at depth to rise towards the surface and be deposited in favourable sites during their upwards passage (e.g. Willman and Wilkinson 1992).

The structure of the rocks which form the Grampians has also recently been interpreted as being thin-skinned (Cayley and Taylor 1997). The tilted sedimentary strata are no longer viewed as a 7000 m thick gently deformed in-situ depositional trough. Instead, a sedimentary package originally only half this thickness was stacked by a complex fault system, probably forming a high mountain range which was then partially segmented and pulled apart by a different, later set of extensional faults. These extensional faults again flatten out into a crustal level where a detachment fault separates the younger Grampians rocks as a thin skin over older, unrelated rocks below (Fig. 4). This deformation style in the Grampians is a different type of thin-skinned tectonics to the rest of western Victoria – one driven by extension rather than shortening of the crust.

Conclusions

Thin-skinned tectonics has revolutionised the way the deformation history and crustal architecture of Victoria is viewed. Whilst the surface distribution of rocks on the map face is little altered, the cross-sec-

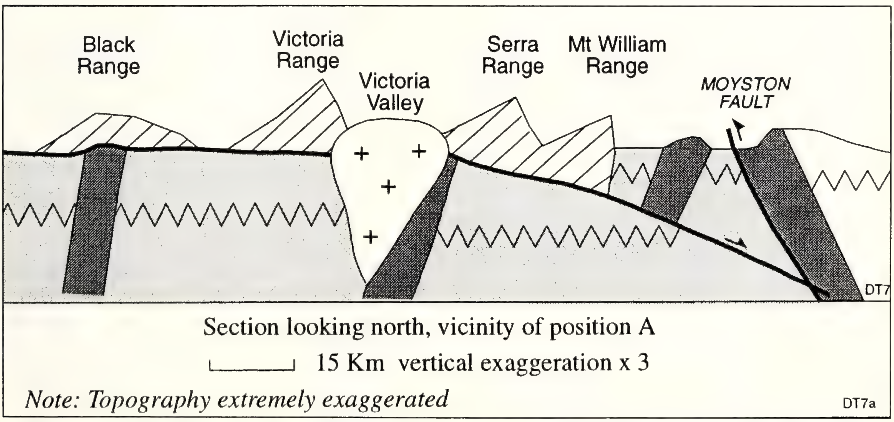

Fig. 4. Schematic cross-section of the thin-skinned tectonic interpretation of the Grampians region. Note the thin layer of deformed Grampians rocks separated from older underlying rocks by a flat detachment fault.

tional slice representing the layered crust with respect to depth is profoundly different. These ideas have been successfully applied to much of western Victoria where new map coverage is nearly complete. Thin-skinned tectonics is also applicable to eastern Victoria and an overall synthesis of this still ongoing mapping in this more rugged country will shortly be available.

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Letter to the Editor

SIR,—I was greatly pleased, when present at your conversazione last week, to hear Professor Spencer say that at last there was some reasonable chance of an early extension of the buildings at the National Museum. Having waited so long it may seem rather injudicious to propose any opposition on account of which the matter may be indefinitely postponed, but at the risk of so doing I would venture to suggest that the Field Naturalists' Club should exert its influence in favour of the removal of the National Museum to a more central and accessible site, say at the Public Library, where there is room for an annexe, similar to the picture galleries, along the Latrobe-street frontage. Here a museum would be in close proximity to the existing literature, and thus permit of greater facilities to study. It may be said that the Musuem is required at the University for teaching purposes, but I think on inquiry it will be found that biological and other schools possess nearly enough typical specimens, and that if more are required they can easily be spared from the National collection. The so-called assistants' rooms at the Museum are a disgrace to Victoria, and the whole of the accommodation is far behind that of the Australian Museum, Sydney, as I remember it some years ago.

Along with others I deeply deplore the death of the late director, Sir F. McCoy, but think that now, as there is a vacancy in the management, is the time to bring the Museum more within reach of the average citizen and student. —I am, &c.,

KANGAROO.

Melbourne, 27th May, 1899

["Kangaroo," and doubtless other readers, will be pleased to know that the desirability of removing the Museum as suggested above was affirmed at a meeting of the trustees on the 1st inst., and at the same time Professor Spencer was appointed honorary director.—ED. *Vict. Nat.*]

From *The Victorian Naturalist*, one hundred years ago, Vol. **XVI**, No. 3, 1899.

A Forester's Log: the Story of John La Gerche and the Ballarat-Creswick State Forest 1882-1897

by Angela Taylor

Publisher: *Melbourne University Press, 1998.*
224 pp., maps and photographs (black & white). RRP $29.95.

The physical appearance of a forest, or any other type of vegetation, does not reveal the complete story of its past. Certainly there are visible clues such as the diversity of species, the density and age of trees and the presence of axed stumps. Other clues exist elsewhere–in the soil profile and in the memories and records of Aboriginal and European Australians.

Angela Taylor has used the records of an early forester to provide some late nineteenth century glimpses of a Victorian forest. The forester is John La Gerche and the forest is the `open forest of mixed species of eucalyptus [which] merges with serried ranks of plantation pines' near Creswick, where Australia's first forestry school was established in 1910. La Gerche's work in the 1880s and 1890s significantly shaped Creswick's eucalypt forest and pine plantations.

The forest between the goldfields of Creswick and Ballarat was one of many areas which, in the second half of the nineteenth century, were reserved as Victorian State forests. In 1882 La Gerche was appointed Crown Lands Bailiff and Forester `to supervise the Ballarat & Creswick State Forest and to take legal proceedings under the 1869 Land Act against all persons found cutting or removing timber in the forest'. Using the comments he recorded in his official Letter Books (into which he copied all his official correspondence - inwards and outwards) and his Pocket Books (in which he pencilled field notes while out in the forest) Angela Taylor has re-presented La Gerche's perceptions of the forest. Executing his dual role as bailiff and forester was difficult but essential. By 1882 the forest had endured three decades of exploitation to satisfy the needs of goldmining and other European activities. Its regeneration and survival required the protection of seedlings from marauding rabbits and goats, and saplings from men seeking mine props and fuel. As well as attempting to protect the forest to allow its regeneration, La Gerche attempted to reclothe hillsides stripped bare by miners and tested a wide range of tree seedlings. He established a nursery at Sawpit Gully, where he germinated thousands of seedlings including Blue Gum, Black Wattle, Golden Wattle and Radiata Pine, and established plantations nearby.

John La Gerche was not a Club member. However, since Angela Taylor writes so engagingly about his work in the forest, this book may interest current FNCV members and other readers of *The Victorian Naturalist* who share my interest in forest history. I thank Angela Taylor for applying her historical intellect to La Gerche's Letter Books and Pocket Books and I thank those who ensured that these unique archival records were not lost.

La Gerche's plantations in Sawpit Gully are now on the Register of the National Estate. By the time you read this review, the La Gerche Walking Track* through them should be completed. My daughter, who is beginning university forest science studies this year, returned from a preliminary visit to Creswick with the hot-off-the-press track leaflet from the Creswick Landcare Centre. Now you can enjoy reading La Gerche's nineteenth century forest perceptions in *A Forester's Log* and walk through the landscape which has been shaped by his efforts over a century ago.

*Postscript. The Track has just won a Victorian Community and Local History Award.

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An Australian Sea Lion on Phillip Island, Victoria

Roger Kirkwood[1], Jenny Hibble[2] and Ian Jerret[3]

Abstract
A weak, adult, male Australian Sea Lion *Neophoca cinerea* came ashore on Phillip Island, Victoria in June 1998, the first reported sighting of this species in eastern Victoria for over 100 years. The sea lion was suffering from a severe lung infection and was euthanased to reduce the possible spread of disease. Based on growth rings in its teeth, the animal was 12 years old. (*The Victorian Naturalist* **116** (3), 1999, pp. 98-101).

Introduction

Australian Sea Lions *Neophoca cinerea* breed at colonies in South and Western Australia and have an estimated total population of 9900 to 12 400 animals (Gales *et al.* 1994; Dennis and Shaughnessy 1996). Although they were distributed more widely prior to sealing activities in the 1800s (Warneke 1982), their currently known foraging range is restricted to the coastal waters of South Australia and southern Western Australia. Occasionally, though, individuals are sighted in Victoria (Menkhorst 1995), Tasmania (Kirkwood *et al.* 1992), and New South Wales (Fulton 1990, P. Shaughnessy *pers. comm.*) (Fig. 1a). Here we report on the first such sighting of an Australian Sea Lion in eastern Victoria, as well as the death of the animal and its subsequent autopsy, which aimed to determine why it could have arrived in this area.

Description of sighting

During the afternoon of 6 June 1998, a 'large seal' came ashore at Sunderland Bay, Phillip Island (Fig. 1b). Local residents saw the seal move up a steep track, across a road and into a residential area, and reported the sighting to the Phillip Island Nature Park (PINP). One of us (RK) identified the animal as an adult male Australian Sea Lion and estimated it to be 1.9 m long and 150 kg in body mass. It appeared thin and weak, but was able to return to the sea during the night, as evidenced by its tracks across the beach the next morning.

During the afternoon of 16 June, a '2 m-long dead seal' at Shelly Beach, Phillip Island (Fig. 1b) was observed and reported to the PINP. The animal was not present when searched for by us one hour after the sighting. It may have been the underweight sea lion that actually was alive and capable of returning to the sea.

In the evening of 17 June, the same sea lion that had come ashore at Sunderland Bay (identified by patterns of scars on its neck and shoulders) was found in a backyard in Ventnor (Fig. 1b). It probably came ashore on Ventnor Beach, entered a creek behind the beach, swam inland about 1 km, then crossed 400 m of open farmland to arrive at the residential block. The sea lion did not change its position during the night and the next morning it appeared to be close to death, in the opinion of a veterinarian (JH). It was thin, could only snarl (without raising its head) when approached to within 2 m, and its breathing was laboured. We suspected the animal could have had a tuberculosis infection, which is known to occur in Australian Sea Lions (Cousins *et al.* 1993). Under the supervision of Department of Natural Resources and Environment Officers (David Cass and Grant Griffin) the sea lion was euthanased using a shot-gun fired at the head from a distance of less than 5 cm.

We took precautions to ensure non-transferral of the potential infection; the ground where the sea lion had lain was doused in petrol and burnt, the sea lion and its body fluids were contained in a plastic sheet and transported directly to a 3 m deep burial pit. Also, all handlers wore disposable gloves and breathing masks. Prior to being buried, the sea lion was autopsied (by JH and RK), its stomach contents were examined and

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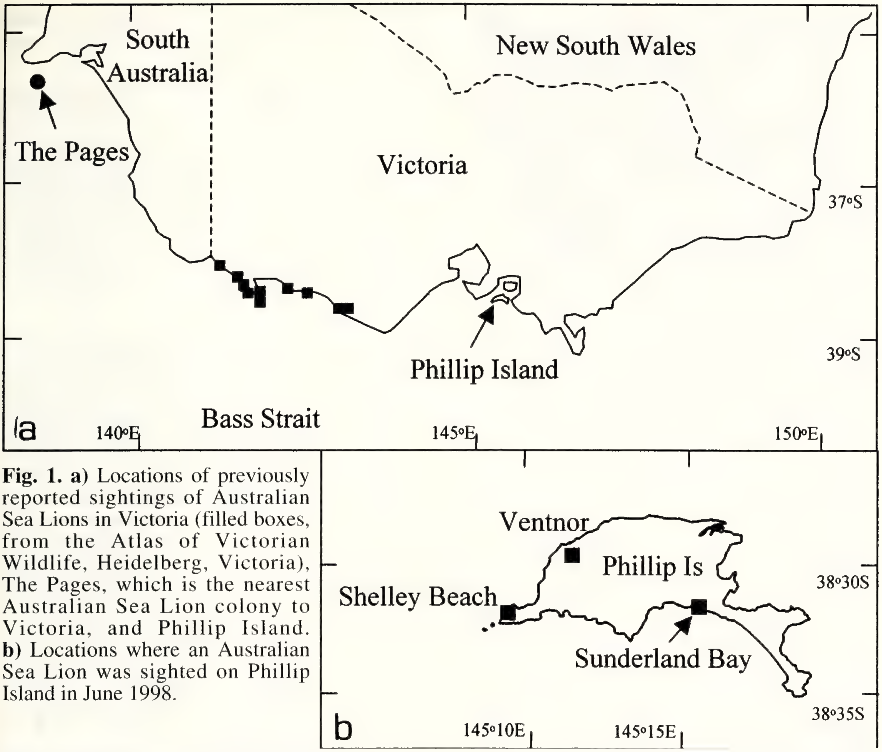

Fig. 1. a) Locations of previously reported sightings of Australian Sea Lions in Victoria (filled boxes, from the Atlas of Victorian Wildlife, Heidelberg, Victoria), The Pages, which is the nearest Australian Sea Lion colony to Victoria, and Phillip Island. **b)** Locations where an Australian Sea Lion was sighted on Phillip Island in June 1998.

several teeth were removed from its jaw for ageing.

Results and Discussion

Autopsy

The sea lion had no obvious external wounds. Several teeth were missing and those present were worn, but there was no sign of a major infection to the jaw, which sometimes is apparent in beachwashed fur seals (RK *pers. obs.*). From our experience at autopsying a range of beachwashed marine mammals, the internal tissues appeared to be normal for an otariid, in all organs except the lungs. Three-quarters of each lung exhibited generalised lesions, with only the lower sections being intact. The lesions did not have the appearance of a tuberculosis infection, which causes hard, white granulomas in fur seal lungs (RK *pers. obs.*). Samples of lung tissue were sent to Ian Jerret at the Gippsland Pathology Service, Bairnsdale, for histopathological and bacteriological examination.

The sea lion's stomach contained three, egg-shaped stones (700 g total mass, each 70–100 mm long), 16 cephalopod beaks and approximately 50 cartilaginous vertebrae from an elasmobranch. Cephalopod beaks were sent to Robyn Ickeringill (Museum of Victoria) for identification. No flesh was present in the sea lion's stomach to indicate that it had fed in the few days prior to death. Several ascarid parasites were removed from the intestinal walls and sent to the Gippsland Pathology Service for identification.

Laboratory analysis

Macroscopic examination of the sea lion's lung tissue suggested a probable bronchopneumonia. The tissue contained numerous pale areas, 2–4 mm in diameter. Microscopic examination revealed a diffuse neutrophil and macrophage infiltration of the bronchioles and alveoli. There were multiple peribronchial and interstitial areas of plasma cell and lymphocyte accumulation as well as widespread atelectasis and multifocal intra-alveolar haemorrhages. The diagnosis was chronic suppurative bronchopneumonia; the tissue

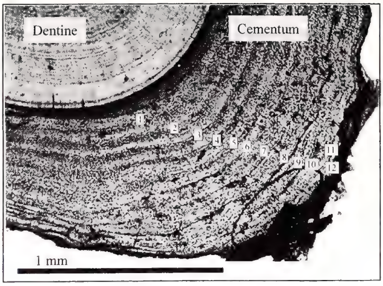

Fig. 2. A cross-section of a canine from the Australian Sea Lion that came ashore on Phillip Island. Numbers indicate growth rings in the cementum of the canine.

changes were suggestive of a non-specific bacterial infection but with no evidence of tuberculosis.

Stomach contents

The occurrence of stones in the stomach of the sea lion was normal (Walker and Ling 1981). Australian Sea Lions deliberately swallow stones that remain in their stomachs and presumably assist with digestion (Needham 1997).

The cephalopod beaks included three lower *Sepia* beaks (cuttlefish), six upper and two lower Ommastrephid beaks (squid) and five unidentified beaks. Descriptions of Australian Sea Lion diet (Walker and Ling 1981, Gales and Cheal 1992) suggest that these cephalopods, as well as elasmobranchs which were represented by the vertebrae, are normal prey for this species.

The ascarid parasites removed from the intestinal walls of the sea lion were identified as *Contracaecum ogmorhinis*, a common parasite in Australian Sea Lions (Johnston and Mawson 1941). These parasites may cause gastric ulcers in sea lions, but generally are considered to be of low pathogenicity.

Ageing

Teeth from the sea lion were sectioned and stained (hematoxylin and eosin) following the procedures outlined in Johnston and Watt (1980). A total of 12 growth rings were evident in the cementum of the canines (Fig. 2). Assuming the rings represented annual growth (as has been demonstrated for other otariids such as the Antarctic Fur Seal *Arctocephalus gazella*, Arnbom *et al.* 1992), the sea lion was 12 years of age. This is old for male sea lions, which rarely live more than 12 years (Stirling 1972).

There appeared to be a change in the growth pattern of the canine's cementum after the laying-down of the fifth growth ring (see Fig. 2). Australian Sea Lions mature at about five years of age and the changed growth pattern in the cementum may reflect a behavioural or physiological modification in response to maturation.

Conclusions

This paper describes the rare sighting of an Australian Sea Lion outside South and Western Australian waters, and the first record, since sealers' accounts, of this species in eastern Victoria. In the 1800s, Australian Sea Lions bred at several locations in Bass Strait, but sealers eliminated their colonies (Warneke 1982). Since 1973, 13 Australian Sea Lions have been recorded in western Victoria, one in southern Tasmania and three on the New South Wales south coast (Menkhorst 1995 and unpublished reports to the Atlas of Victorian Wildlife, Kirkwood *et al.* 1992, Fulton 1990 and P. Shaughnessy *pers. comm.*). Like the Phillip Island sea lion, most sightings have been of large males, although some females also have been noted. The apparently rare visits to Bass Strait waters may be occasional wanderings by individuals away from the species' normal foraging range. Alternatively, Australian Sea Lions may forage regularly in Bass Strait waters, but rarely come ashore on coasts where they can be sighted.

Australian Sea Lions are known to occasionally travel inland. Individuals have been found up to 10 km from the coast (Wood-Jones 1925), so it was not exceptional for the sea lion on Phillip Island to travel 1 km inland. The animal's poor condition (bronchopneumonia and starvation), however, probably impared its judgement, which may have influenced its movement away from the sea.

The frequency of occurrence of bronchopneumonia in sea lions is unknown, but it has been a common infection in other otariids that have come ashore in poor condition on Victorian beaches (Beasley 1998). In the present instance, old age may have reduced the sea lion's ability to tolerate infection

making it susceptible to the broncho-pneumonia.

This sea lion was euthanased because we suspected that it had a tuberculosis infection. We recommend, however, that pinnipeds that come ashore on beaches in southern Australia normally should be left alone. If the animal appears to be suffering or diseased, a veterinarian should inspect it. Euthanasia is a last resort to end undue suffering by an individual and/or prevent the spread of disease.

Acknowledgements

We wish to thank Pat Russell, Bill Mitchell and Salim Malik (Phillip Island Nature Park), and David Cass and Grant Griffin (Natural Resources and Environment) for assistance with handling the sea lion, Robyn Ickeringill (Museum of Victoria) for identifying the cephalopod beaks, and Frank Busana (Victorian Institute of Animal Science) for assistance with the tooth preparation. We also thank the Atlas of Victorian Wildlife (email: bjb@nre.vic.gov.au) for supplying records of sea lion sightings in Victoria, Peter Shaughnessy for his personal communication of a recent sea lion sighting in New South Wales and an anonymous reviewer for improving a draft of the manuscript. The sea lion was autopsied under NRE Research Permit No: RP-97-236.

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The Australian Natural History Medallion, which was instituted in 1939, is awarded annually to a person who, in the preceding ten years, has made a significant contribution to the understanding of natural history in Australia.

Hydroids from Ricketts Point and Black Rock, Victoria

Jeanette E Watson[1] and the late Daniel E. McInnes[2]

Abstract
Daniel McInnes, naturalist and microbiologist (3/10/1906–24/9/98) left many notes but published few results of his observations over many years on the Hydrozoa from Port Phillip Bay. In this paper his research notes on hydroids collected during the 1980s are collated and edited. The paper describes six species of athecate hydroids, two of which are first records for their respective genera in Australia, two are Australian species not reported since their first description and four thecate species including one probably new species. (*The Victorian Naturalist* **116** (3), 1999, pp. 102-111).

Introduction

Daniel McInnes, naturalist and microbiologist (3/10/1906 – 24/9/98) left many notes but published few results of his observations over many years on the Hydrozoa of Port Phillip Bay. During the 1980s he regularly collected intertidal and shallow water hydroids from the Melbourne seaside suburbs of Black Rock (37° 58' S, 145° 01' E) and Ricketts Point (38° 00' S, 145°02' E) in Beaumaris. He found many hydroids growing on common seaweeds near shore and in tide pools on the rock platform. Species on which he found hydroid epiphytes were the green alga *Ulva*, holdfasts and thalli of the brown kelps *Ecklonia radiata* and *Cystophora* sp. and the red coralline alga *Corallina officinalis*.

He examined his collections in the small laboratory and seawater aquarium at his home in the suburb of Malvern. The aquarium system consisted essentially of aerated glass tanks and an array of plastic containers. Interesting specimens selected under the microscope were isolated in glass petrie dishes in the containers. Hydroids that particularly caught his attention were the small, cryptic species which have received little study in Australia. A detailed account of his collection methods and aquarium maintenance are given in McInnes (1982).

He kept a behavioural diary of his aquarium specimens, including copious weekly, daily and sometimes hourly notes and diagrams of interesting specimens. (One such note plaintively asks 'Oh! where has my medusa gone?' An hour later according to his diary, the errant medusa was found hidden under algae.) Although his measurements and drawings are accurate, unfortunately he left no preserved or mounted voucher or type specimens, presumably because he continued observations until the specimens died.

A difficulty I encountered in reviewing his data is that in many instances, he did not name the specimens under observation, providing only a reference such as 'hydroid in red container 3'. Those specimens which he was able to name were usually correct to genus and generally to species; often, however, these were old names now synonymised in the modern literature.

I suspect that his lack of rigorous scientific publication was a matter of diffidence and that he (quite wrongly) considered himself to be an amateur whose efforts in taxonomy would be unworthy of scientific recognition. As a tribute to his work I now try to set the record straight. I have been able to extract and summarise from his notes the following information: two species are first records of their respective genera from Australia; two species have not been reported in Australia since their first description and gaps in life histories of some others have now been filled. Because of insufficient information and unfinished sketches I regretfully exclude several other unusual athecate species. Three thecate species including one almost certainly new to science are reported and other common athecate and thecate hydroids he found on algae are listed. For clarity in publication it has been necessary to redraw many of his sketches from the microscope. In keeping with what I am sure would have been his wish, in this paper he is referred to simply as 'Dan'.

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Subclass Anthoathecata
Family Clavidae McCrady, 1859
***Clava* Gmelin, 1791**
***Clava* sp.**
Fig. 1A

Material

Colony collected 7/3/85 from underside of *Ecklonia radiata* holdfast; colony survived until 18/4/85. Another colony of many dozens of hydranths collected 8/4/87.

Description

Hydranths arising directly from a creeping stolon; stolon and hydranth pedicel covered by thin perisarc. Hydranth cylindrical, young hydranth with four oral tentacles, probably moniliform, 0.3–0.4 mm long but tentacles not in a whorl; hypostome clavate. Tentacles increasing in number to 18, scattered over hydranth body, older (distal) tentacles up to 0.8 mm in length, proximal ones shorter. Hydranth up to 2 mm high at

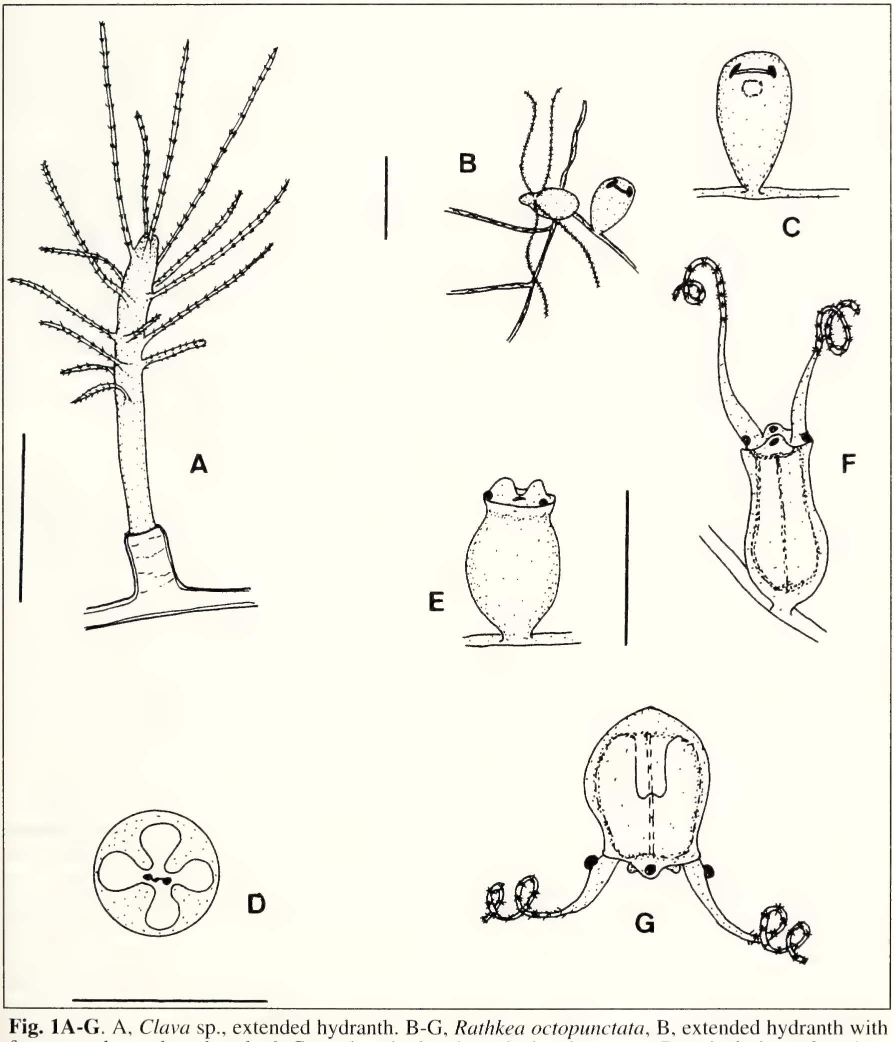

Fig. 1A-G. A, *Clava* sp., extended hydranth. B-G, *Rathkea octopunctata*, B, extended hydranth with four tentacles and medusa bud, C, medusa bud, enlarged, showing spots, D, apical view of medusa bud, E, more advanced medusa with tentacle bulbs, F, medusa with newly extended tentacles, G, liberated medusa. Scale bar: 0.5 mm.

maturity, pedicel about 1.2 mm long.

Colour Hydranths colourless to grey.

Remarks

One stolon grew to a length of 8.5 mm. The number of tentacles on the hydranth increased from four to 10 over a period of nine days. During this time one of the hydranths was observed feeding on an amphipod.

One of the problems encountered in rearing very small hydroid colonies detached from their substrate is inducing re-attachment to new substrata in the aquarium. Dan apparently successfully solved this with *Clava* by embedding the stolons in a blob of petroleum jelly on the bottom of a petrie dish.

This may be the species listed by Dan as *Turris neglecta* Lesson (McInnes 1982). In the absence of reproductive structures and without information on the cnidome the species cannot be identified. There are no previous records of the genus *Clava* from Australia.

Family Rathkeidae Russell, 1953
***Rathkea* Brandt, 1838**
***Rathkea octopunctata* (M. Sars, 1835)**
Fig. 1B-G

Cytaeis octopunctata M. Sars, 1835: 38, pl. 6, figs 14a-g.
Rathkea octopunctata- Russell, 1953: 137, pl. 7, figs 3-4, text-figs 65A-E, 66, 67A-B.- Southcott, 1982: 130, fig. 4.20a, b.- Schuchert, 1996: 49, fig. 34a-c.- Watson, 1998.

Material

Colonies first found in 1982. Colonies collected in April 1986 were maintained in aquaria until November 1986, during which period the hydranths multiplied on glass to 30 - 40 individuals and at least two medusae were released.

Description

Colonies stolonal, hydranths arising from a ramified, creeping hydrorhiza. Hydranths pyriform to spindle-shaped, capable of extension to 0.3 mm, with four thread-like filiform oral tentacles up to 2 mm in length.

Juvenile gonophores ovoid, 0.5 mm high and 0.3 mm wide, borne erect from stolon on a very short pedicel. Viewed from above, the young medusa within the gonophore has four thick internal lobes, probably radial canals, and two central red spots connected by a thin red line (Fig. 1D). After four days the gonophore became vase-shaped with two opposite, protruding, thick tentacle bulbs; base of bulbs with red spots. At this stage the medusa commenced pulsing inside the gonophore.

Over several hours the gonophore extended to 0.6 mm in length and the two tentacle bulbs became elongated into two long, filiform tentacles armed with nematocysts in the distal third; two more thick tentacle bulbs appeared opposite the original tentacles. The red spots, present at the base of each bulb, now enlarged into perradial vesicles.

Several hours later, the medusa was released. At this stage the umbrella was balloon-shaped, 0.6 mm high and 0.4 mm wide, slightly thickened apically, with faint radial canals passing down the umbrella to the tentacle bases. A quadrangular manubrium extended more than halfway through the bell; mouth a simple broad disk. The gonophore remained as a transparent deflated sheath. The observations ended with death of the medusa.

Remarks

There are five known species of *Rathkea* medusae (O'Sullivan 1984), of which *Rathkea formosissima* and *Rathkea octopunctata* have been reported from New Zealand (Schuchert 1996) and *R. octopunctata* from Port Phillip Bay, Australia (Southcott 1982). Of these species, only the hydroid stage of *R. octopunctata* has been conclusively associated with its medusa (Russell 1953). Watson (1998) recorded an infertile hydroid growing on a muddy bottom in the Geelong Arm of Port Phillip Bay and doubtfully referred it to that species. Dan's sketch of the hydroid exactly matches the description and figure of *Rathkea octopunctata* given by Watson (1998).

The newly liberated medusa of *R. octopunctata* from the parent hydroid has never previously been described, the smallest specimens taken from the plankton of the British Isles being about 1 mm in height (Russell 1953). Only adult specimens 2.5–4 mm high have been reported from the plankton of New Zealand (Schuchert

1996) and Australia (Southcott 1982).

A puzzling aspect is the red spots, developing into prominent pustules near the base of the tentacles. As they occur on the tentacle and not the circular canal, these are not ocelli which, in any case, are excluded from the family definition of the Rathkeidae. No such structures are mentioned in descriptions of more advanced medusae; it is possible that these are lost as the medusa matures.

The family definition of Rathkeidae also includes short oral arms on the manubrium and multiple sets of tentacles on the adult medusa. Increase in the number of tentacles is a common event in maturation of hydrozoan medusae so it is equally possible that in this species the oral tentacles may also grow at a later stage of development.

Until the report by Watson (1998) and the present account, the hydroid of *R. octopunctata* was known only from some cultured specimens reared in overseas laboratories (Russell 1953, Werner 1958). This account fills a gap in the natural life history of the species.

Family Corynidae Johnston, 1836

***Coryne* Gaertner, 1774**

Coryne sp.

Fig. 2A

Material

Collected from holdfast of *Ecklonia radiata*, 24/4/85; no other information.

Description

Part of a small colony, simple and sparsely branched, diameter of branch 0.25 mm, perisarc almost smooth, reaching to base of hydranth. Hydranth 1.5 mm long, with an oral whorl of four capitate tentacles and (probably) 16–18 capitate tentacles scattered over body. Gonophores are fixed sporosacs scattered among tentacles; gonophore balloon-shaped, about 0.5 mm long with a short peduncle and thick clear pellicle; sex probably male.

Colour Sporosac orange.

Remarks

The specimen bears some similarities to *Coryne* sp.1 of Schuchert (1996), small colonies of which were found on stones and other cryptic habitats in New Zealand. Unfortunately, without information on the cnidome of Dan's specimen, no further identification is possible. This is the first record of the genus *Coryne* from Australia.

Dicoryne Allman, 1859

***Dicoryne annulata* von Lendenfeld, 1884**

Fig. 2B

Dicoryne annulata von Lendenfeld, 1884: 490, pl. 17, fig. 30.

Material

Colonies collected 17/5/82, 10/9/82, 5/11/82. Another colony collected from red coralline alga 22/1/82.

Description

Colonies infertile. No information on hydrorhiza. Hydranth pedicel cylindrical, 0.6 mm long, 0.18 mm wide, perisarc moderately thick, deeply annulated. Extended hydranth 1.3–1.5 mm long, spindle-shaped, with 16–18 distal filiform tentacles to 0.8 mm long, hypostome an open annulus.

Remarks

This is undoubtedly *Dicoryne annulata* described by von Lendenfeld from Port Phillip Bay.

Dan left no information on the species other than the scale drawing of the hydranth and hydranth bud. The species has not been recorded since its first description.

Sarsia Lesson, 1843

***Sarsia radiata* von Lendenfeld, 1884**

Fig. 2C

Sarsia radiata von Lendenfeld, 1884: 583, pl. 20, figs 31, 32.- Watson, 1978: 305, fig. 2A-D.

Material

Collected 25/4/82; no other information.

Description

Hydranth 1 mm high, arising from a stolon (not sketched). Hydranth with four oral tentacles and nine to 10 tentacles scattered over body; all tentacles long, capitate, capitulum armed with nematocysts. Medusa 0.7 mm long and 0.6 mm wide, on a short pedicel below proximal tentacles, umbrella balloon-shaped, with four radial canals and four long tentacles armed with nematocysts; velum broad, almost quadrate in shape, opening small, circular. Manubrium cylindrical narrowing to a simple mouth.

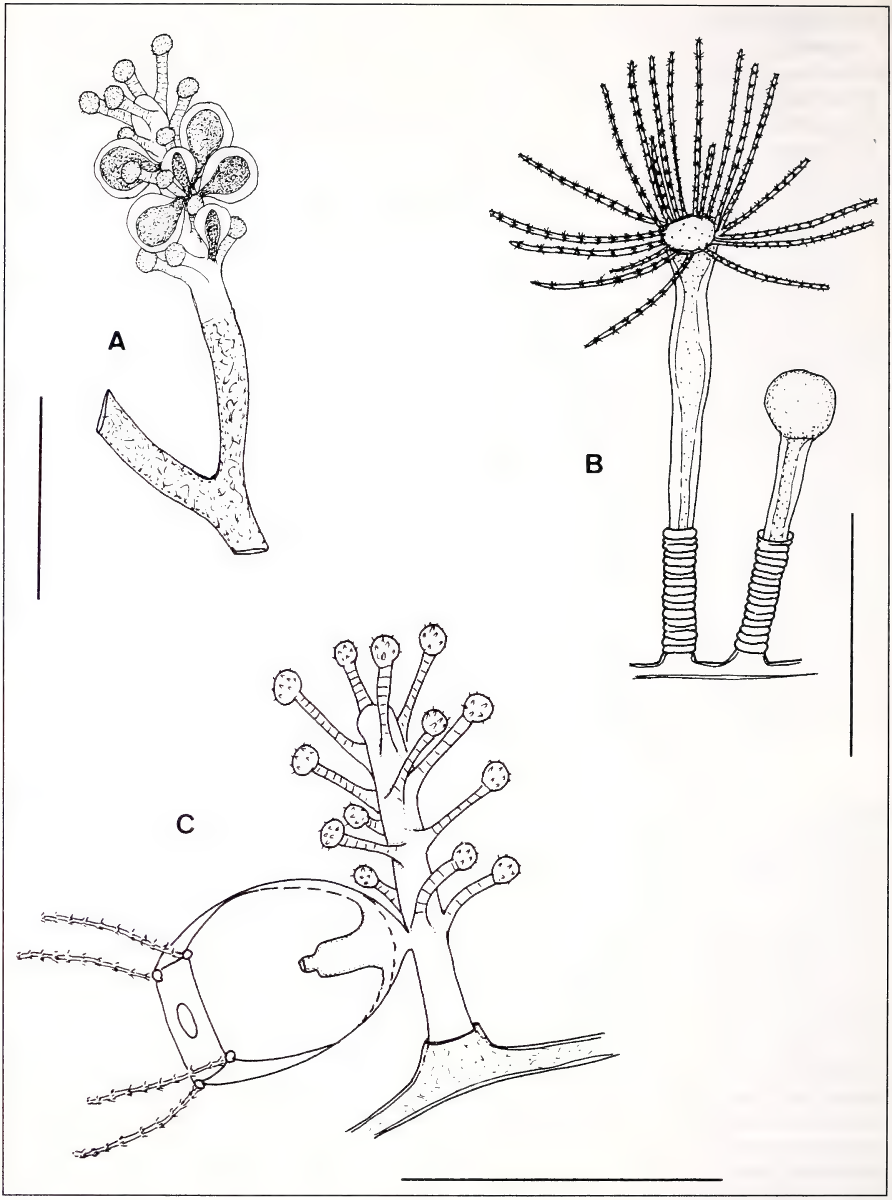

Fig. 2A-C. A, *Coryne* sp., simple branch with hydranth and sporosacs. B, *Dicoryne annulata*, extended hydranth and hydranth bud. C, *Sarsia radiata*, extended hydranth and medusa about to be released. Scale bar: A, 0.5 mm, B, C, 1 mm.

Remarks

This is probably the species referred by Dan to *Stauridiosarsia producta* (Wright), (see McInnes 1982: 163). Although he provided no notes and his sketch lacks detail, especially in relation to the basal perisarc of the hydroid, the species is clearly *Sarsia radiata*, previously reported from Port Phillip Bay by Watson (1978). The medusa was released in the aquarium.

Family Aequoreidae Eschscholtz, 1829
***Aequorea* Péron & Lesueur, 1810**
***Aequorea* sp.**
Fig. 3A-C

Material

Hydroid colony with medusa bud collected 25/4/82; medusa released in laboratory from colony. Medusa collected 5/11/82. Dan noted (26/9/86), that the colonies had been 'in the (petrie) dishes for years, giving birth to medusae, and are the toughest of all hydroids, despite very cold to very hot weather and "crook" seawater'.

Description

Colony stolonal, hydrorhiza tubular, creeping. Hydranth and medusa buds arising on short annulated pedicels from hydrorhiza; pedicel expanding distally from base. Hydranth 2.5 mm long, spindle-shaped, body slightly swollen below tentacle ring. Hydranth with 12 probably moniliform tentacles 2 mm long, a large basal tentacle web 0.25 mm wide; hypostome circular.

Cnidome of hydroid consisting of two size classes of nematocysts, probably isorhizas:

1) capsule bean-shaped, 7.5 × 3.5 μm tubule 350 μm long.

2) capsule bean-shaped, 15 × 7.5 μm, tubule 100 μm long.

Medusa buds borne on hydrorhiza and hydranth pedicel, the more advanced bud 0.5 mm high and 0.4 mm wide, showing a well developed manubrium and radial canals. Medusa at release balloon-shaped, bell 0.6 mm high and 0.6 mm wide, with four radial canals and a cylindrical

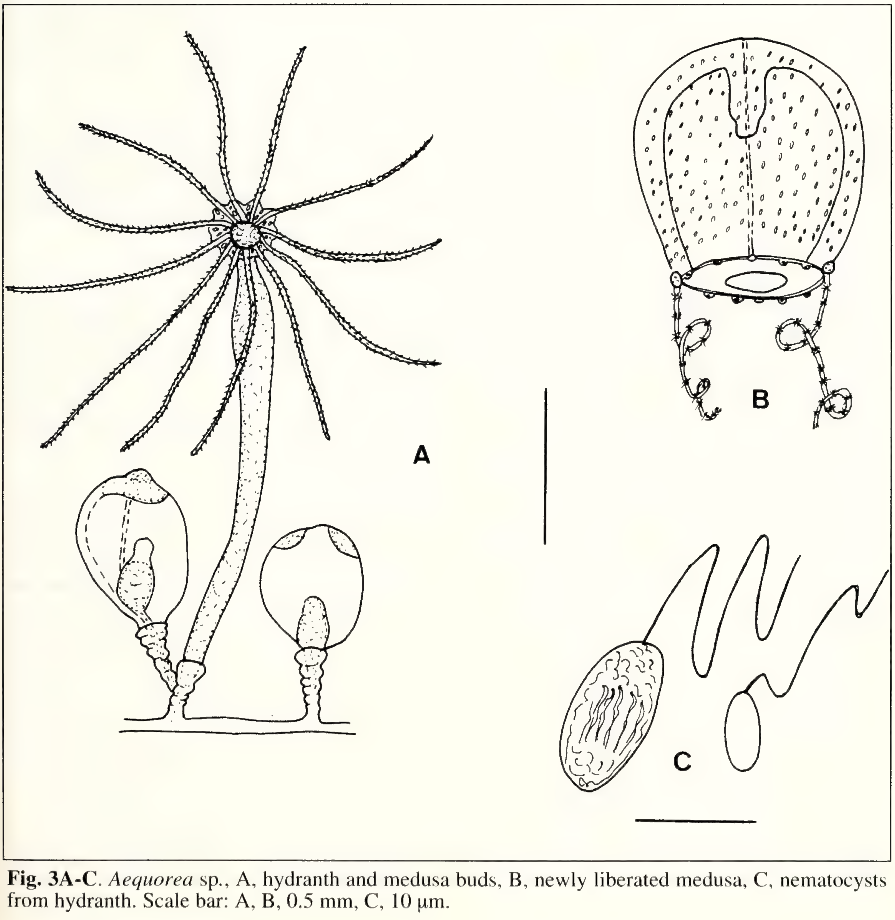

Fig. 3A-C. *Aequorea* sp., A, hydranth and medusa buds, B, newly liberated medusa, C, nematocysts from hydranth. Scale bar: A, B, 0.5 mm, C, 10 μm.

manubrium narrowing to simple tubular lips; exumbrella covered by numerous scattered large nematocysts, base of bell with two opposite long moniliform tentacles with swollen bulbs and two opposite perradial tentacle bulbs at base of radial canals, ring canal narrow, eight interradial marginal vesicles with concretions, velum broad.

Remarks

There is indication in his laboratory notes (see McInnes 1982: 163) that Dan assumed this hydroid to be a species of *Perigonimus* Sars. However, the medusa has features described for juveniles of *Aequorea forskalea* (Péron and Lesueur 1809) in the concretionary vesicles of the ring canal, and of *Aequorea vitrina* Gosse, 1853, in the almost complete cover of the exumbrella by large nematocysts.

The figured cnidome is from the tentacle web of the hydroid and it is possible that these, and the tentacular nematocysts, are different from those of the medusa. The nematocysts cannot be further identified as there is no information on the armature of the tubule.

The problem with precise identification of species of *Aequorea* is that the hydroid and early life histories of most common *Aequorea* medusae in the world plankton are virtually unknown. A further complicating factor is that the relatively large adult medusae bearing many tentacles bear little resemblance to juvenile forms. It is likely that the hydroid *Aequorea phillipensis* Watson 1998 from Port Phillip Bay is the same as that found by Dan; however, this can only be ascertained with collection of more material and further laboratory study.

Family Cladonematidae Gegenbauer, 1857
***Staurocladia haswelli* (Briggs, 1920)**
Fig. 4A, B

Cnidonema haswelli Briggs, 1920: 93 - 104, pls 17, 18.

Material

Several colonies collected from coralline alga, 14/1/82; colony attached to glass of aquarium; observations proceeded until 9/3/82.

Description

New hydranths spindle-shaped, arising about 1 mm apart from a reptant stolon about 0.15 mm diameter; juvenile hydranth with three capitate tentacles increasing to four or five after seven to 10 days, mature hydranth at that stage about 1.5 mm long with a clavate hypostome; medusa buds appear as bulges on lower body and stolons. Medusa small, with four groups of bifurcate tentacles, each with an ocellum at base. Buds grew over four days, in which time the tentacles lengthened with one bifurcation longer than the other. Medusae were released after four to five days, creeping on floor of aquarium. At this stage the aboral tentacles were shorter, each bearing five nematocyst pads - a large terminal pad, two closely adjacent pads a short distance down the tentacle, a smaller pad, almost opposite, and one small pad opposite the bifurcation. The lower, longer (oral) tentacles without nematocysts, but with a bluntly pointed end.

The medusae lived for four days after release during which time 18 tentacles developed and several new medusa buds commenced growth around the manubrium of the parent.

Remarks

Although Briggs (1920) collected many medusae and wrote a detailed account of *Staurocladia haswelli* from the Sydney region, he never discovered the parent hydroid. From Dan's description and sketches there is no doubt that this is the first record of the hydroid of *S. haswelli*. Except for the absence of a ring of aboral tentacles the hydroid resembles other known polyps of *Staurocladia*; the absence of these tentacles may be a normal character of *S. haswelli* or possibly a consequence of the specimens being reared in an aquarium.

Dan mentions that the medusae were fed on amphipods and the hydranths on tubifex worm cut into very small pieces.

Subclass Leptothecata
Family Syntheciidae Marktanner-Turneretscher, 1890
***Hincksella* Billard, 1918**
***Hincksella cylindrica* (Bale, 1888)**
Fig. 4C

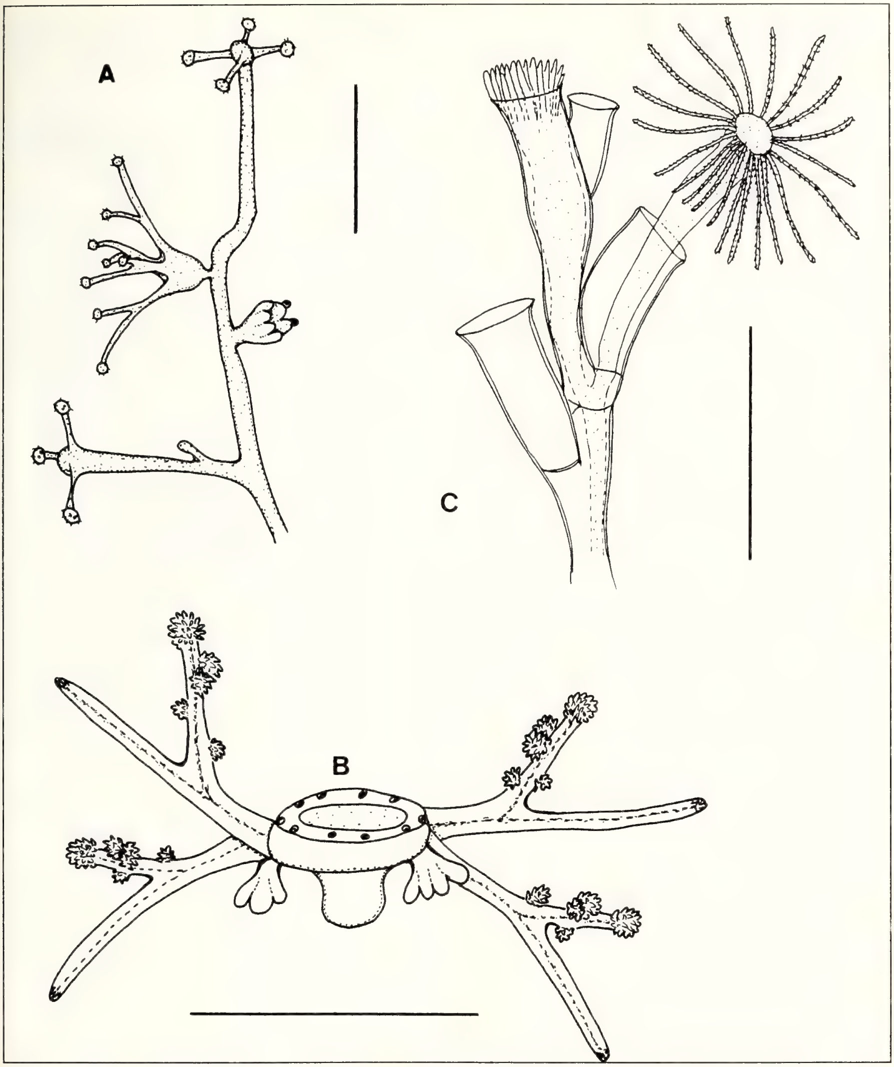

Fig. 4A-C. A, B, *Staurocladia haswelli*, A, colony with hydranths and medusa bud with developing medusae, B, medusa, showing two sets of tentacles only, and medusa buds. C, *Hincksella cylindrica*, hydrothecae and extended hydranth. Scale bar: 1 mm.

Sertularella cylindrica Bale, 1888: 765, pl. 16, fig. 7.- Ralph, 1966: 163.

Material

Colony collected on *Ecklonia* holdfast, February 1985, maintained for approximately eight weeks in aquarium to May, 1985.

Remarks

Dan was uncertain whether the colony with faintly undulated hydrothecae was *Hincksella corrugatum* Millard, 1958 with corrugated hydrothecae or *Hincksella cylindrica* (Bale 1888) with smooth hydrothecae. Ralph (1966) was also uncertain to which species her faintly corrugated specimens from Port Phillip Bay should be referred. As the hydrothecae of Dan's specimens are smooth the species is here assigned to *H. cylindrica*. Probably detailed studies will eventually show the two to be conspecific.

Thecate hydroids are well known to be

intractable aquarium subjects so it is a remarkable achievement to have maintained a thecate colony over this period of time in relatively primitive laboratory conditions.

Family Haleciidae Hincks, 1868
***Halecium* Oken, 1815**
***Halecium fragile* Hodgson, 1950**
Fig. 5A

Halecium fragile Hodgson, 1950: 15, fig. 11a-d.

Material

Colony collected 16/10/82; no other information.

Remarks

This collection date is the first record of the species from Port Phillip Bay.

***Halecium* sp.**
Fig. 5B

Material

Colonies collected twice, the first on

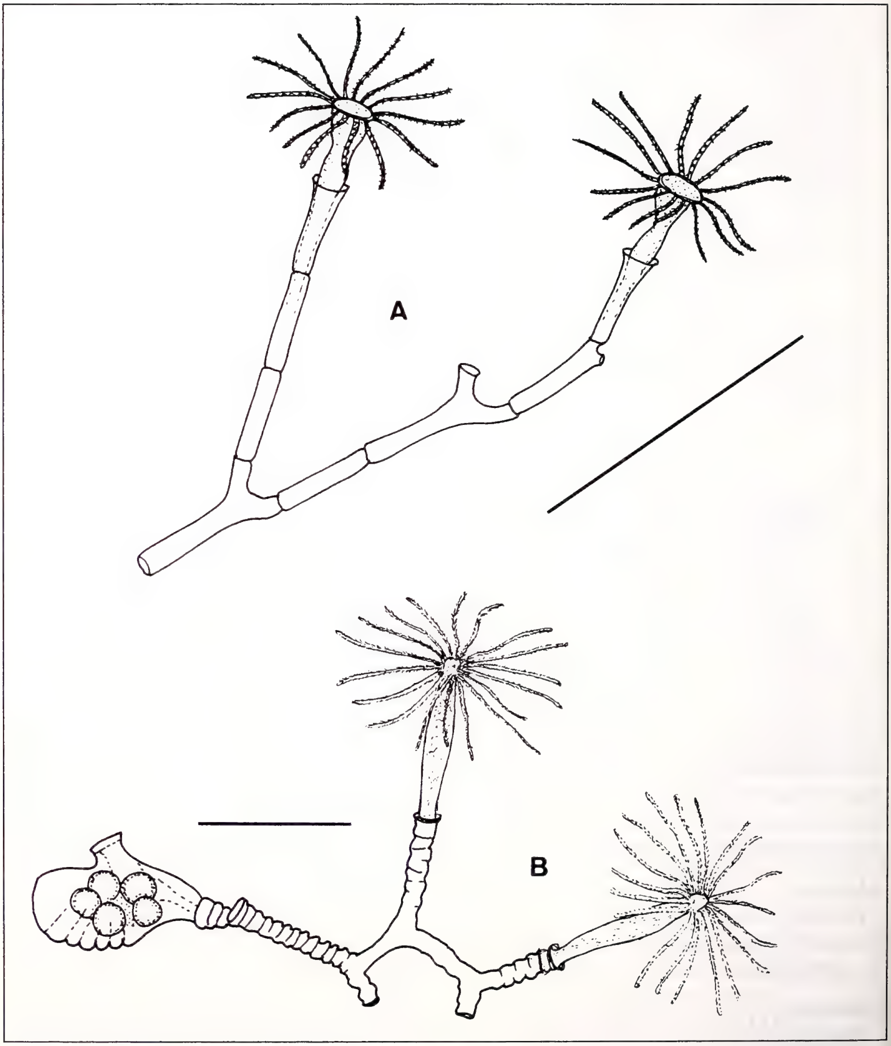

Fig. 5A and 5B. A, *Halecium fragile*, stem and extended hydranths. B, *Halecium* sp., hydrorhiza, hydranths and gonotheca. Scale bar: 1 mm.

2/4/82, the second collection a fertile colony from weed, 25/10/82; this colony maintained in aquarium until 27/12/82.

Description

Hydrorhiza a creeping undulated stolon; hydrothecal pedicels 0.25–0.35 mm high, 0.12–0.13 mm diameter, arising singly at intervals from hydrorhiza; pedicels deeply annulated. Hydrophore shallow dish-shaped (but not clearly figured), hydranth tall, spindle-shaped, with 18–20 tentacles. Gonotheca borne on a short annulated pedicel from hydrorhiza or from side of hydrothecal pedicel, mitten-shaped, aboral side deeply ridged, 0.6 mm long and 0.5 mm wide, orifice (probably) cylindrical, 0.13 mm in diameter, possibly with slightly everted rim. One gonotheca containing several spherical ova.

Remarks

Dan figured the species but left no notes, assuming it to be *Halecium corrugatissimum* Trebilcock, 1928. However, *H. corrugatissimum* is a tall, arborescently branched hydroid, not stolonal as is this species. As there is no other known *Halecium* similar to Dan's figure it is almost certainly an undescribed species. Verification must, however, await the finding of more material.

Supplementary Species List

At various times Dan found other common hydroid species on algae. The list (Table 1) is extracted from his notes (1982-1985) and from McInnes (1982: 163).

Acknowledgements

I thank Mrs C. McInnes for providing me with Dan's notes and permission to publish this resume of his researches on the Hydrozoa.

Table 1. Common Hydroids on Algae from Ricketts Point and Black Rock.

Species	Habitat
Eleutheria dichotoma Quatrefages, 1842	corallines
Eudendrium capillare Alder, 1856	brown alga
Silicularia rosea Meyen, 1834	*Ecklonia* thalli
Orthopyxis caliculata (Hincks, 1853)	brown alga
Clytia hemisphaerica (Linnaeus, 1767)	filamentous red alga
Phialella quadrata (Forbes, 1848)	brown alga
Amphisbetia minima (Thompson, 1879)	*Ecklonia* hold fast
Plumularia ?obliqua (Johnston, 1847)	*Ecklonia* hold fast
Plumularia setaceoides Bale, 1882	*Ecklonia* thalli
Monotheca pulchella (Bale, 1882)	?*Cystophora* thalli
Sertularella robusta Coughtrey, 1876	not given
Monotheca spinulosa (Bale, 1882)	not given
Aglaophenia plumosa Bale, 1882	*Ecklonia* hold fast

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The Booroolong Frog *Litoria booroolongensis* Moore (Anura: Hylidae): an Addition to the Frog Fauna of Victoria.

Graeme R. Gillespie[1] and David Hunter[2]

Abstract
The Booroolong Frog *Litoria booroolongensis* is a lotic species formerly restricted to streams in New South Wales. We report confirmation of the species in north-east Victoria, north of Burrowa Pine Mountain. This species has declined throughout much of its range in New South Wales and is currently listed as Endangered in that State. These records are therefore a significant extension to the known occurrence of the species. (*The Victorian Naturalist* **116** (3), 1999, pp. 112-114).

Introduction

The Booroolong Frog *Litoria booroolongensis* is a riverine species morphologically similar to Lesueur's Frog *L. lesueuri* (Moore 1961, Anstis *et al.* 1998) (Fig. 1). It occurs predominantly along western-flowing streams of the Great Dividing Range in New South Wales, from catchments draining the Northern Tablelands, to the Tumut River in the Southern Highlands, and other tributaries of the Murrumbidgee River (Caughley and Gall 1985; Heatwole *et al.* 1995; Anstis *et al.* 1998; Hunter and Gillespie *in press*). *Litoria booroolongensis* has been recorded close to the north-eastern Victorian border (Caughley and Gall 1985), but previous fauna surveys have not located it in Victoria. This may be because accurate identification of *L. booroolongensis* is difficult, especially in the south of its range where the species is superficially very similar to *L. lesueuri* (G. Gillespie *pers. obs.*). The Australian Museum holds several juvenile *L. booroolongensis* specimens collected in 1961 from the King River, near Wangaratta in Victoria (Australian Museum record nos R90917–R90930). However, examination of these specimens by one of the authors (GG) indicates that they are *L. lesueuri*.

Litoria booroolongensis was formerly abundant along streams draining the Northern Tablelands of New South Wales (Heatwole *et al.* 1995). There have been very few sightings of this species in the past ten years (New South Wales Wildlife Atlas), and concerns have been raised about its current conservation status (Anstis *et al.* 1998). Further south, there are relatively few historical records (Australian Museum records; New South Wales Wildlife Atlas). A recent survey conducted for riverine frogs along west-flowing streams in Kosciuszko National Park failed to find the species at two historic collection sites, and only located it in one stream in the region (Hunter and Gillespie *in press*). The species has recently been listed as endangered in New South Wales (NSW Threatened Species Conservation Act 1995).

Observations

During the summer of 1998/99 we conducted a survey commissioned by the New South Wales National Parks and Wildlife Service, to assess the current distribution of *L. booroolongensis* along the south-western slopes of the Great Dividing Range in New South Wales. During this survey we located the species along three small creeks, several kilometres north of the Murray River, near Jingellic, New South Wales. This led us to suspect that *L. booroolongensis* may also occur along similar small creeks feeding the Murray River from Victoria, north of Burrowa Pine Mountain. We subsequently surveyed four creeks (Burrowye, Walwa, Sandy and Cudgewa Creeks) and the Murray River in this area. *Litoria booroolongensis* was located on Burrowye Creek at Burrowye (36° 2' E; 147° 33' S), and on the banks of the Murray River near Jingellic (35° 56' E; 147° 42' S), confirming the occurrence of the species in Victoria (Fig. 2). Specimens were collected from each of these localities and lodged with the Victorian Museum

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Fig. 1. The Booroolong Frog *Litoria booroolongensis*, from Bombowlie Creek, southern New South Wales. Photo: G. Gillespie.

(Victorian Museum record nos D69973 and D69974).

Our observations in southern New South Wales suggest that *L. booroolongensis* and *L. lesueuri* have allopatric distributions in this region. We found *L. lesueuri* along Cudgewa Creek, and previous surveys in the region have located *L. lesueuri* on most other streams in this region of Victoria (Watson *et al.* 1991; Gillepsie and Hollis 1996; Hunter and Gillespie *in press*; Victorian Wildlife Atlas). *Litoria booroolongensis* is therefore likely to be restricted in Victoria to this region north of Burrowa Pine Mountain.

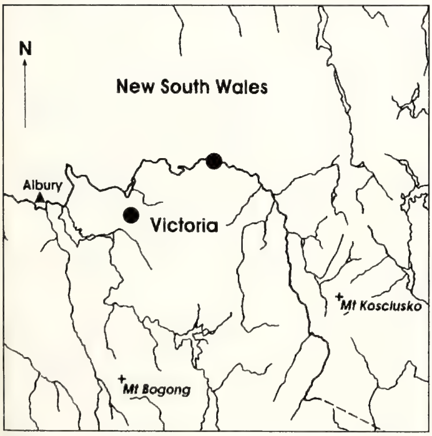

Fig. 2. Localities of *Litoria booroolongensis* (indicated by closed circles) in north-eastern Victoria. (Scale 1 cm = 20 km.)

Litoria booroolongensis inhabits rocky permanent streams, ranging from small slow-flowing creeks to large rivers (Anstis *et al.* 1998; authors' *pers. obs.*). Adults are typically found sheltering under boulders or cobbles near riffles along the stream bank (Anstis *et al.* 1998; authors' *pers. obs.*). The species occurs along streams in both forested areas and open pasture. Sites where we observed the species in Victoria and southern New South Wales were highly modified streams flowing through pasture, and were heavily disturbed and polluted by cattle. In the southern parts of its range, breeding occurs in spring. Eggs are deposited in rock crevices in the stream or in isolated stream-side pools (authors' *pers. obs.*). Tadpoles metamorphose in January and February (Anstis *et al.* 1998).

Identification

Litoria booroolongensis is morphologically very similar to *L. lesueuri*, which is a common and widespread riverine species in south-eastern Australia (Barker *et al.* 1995). The species can be reliably distin-

guished from *L. lesueuri* by the extension of webbing to the base of the first inner toe pad on the hind foot. The webbing on *L. lesueuri* extends only to the base of the penultimate phalange of the first inner toe (authors' *pers. obs.*). *Litoria booroolongensis* typically has a highly mottled dorsum with a scattering of salmon-coloured flecks. *Litoria lesueuri* typically has a distinct black stripe passing through the eye and over the tympanum to the shoulder, whereas this is less distinct in *L. booroolongensis* (Barker *et al.* 1995).

Significance

Litoria booroolongensis is one of a number of riverine species in eastern Australia which have suffered severe population declines over the past two decades (Tyler 1997). Its discovery in Victoria is a significant addition to the frog fauna of the State, taking the total number of species recorded to 35 (Atlas of Victorian Wildlife). Further information is required to determine the current distribution of this species and the causes of its apparent decline, and how best to manage and protect these remaining populations.

Acknowledgements

This work was funded by the New South Wales National Parks and Wildlife Service and the Arthur Rylah Institute, Department of Natural Resources and Environment, Victoria. Ross Saddler (Australian Museum) and John Coventry (Museum of Victoria) kindly provided access to museum specimens. R. Loyn and G. Brown provided comments on the manuscript.

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Erratum

Re 'Emperor: the Magnificent Penguin', review by Peter Dann, in *The Victorian Naturalist* **116** (2), 46. Pauline Reilly was not the first female President of the R.A.O.U. A Mrs. Perrine Moncrieff, of New Zealand, had that honour. She was President during 1932-33. Thanks to Mrs Tess Kloot for pointing this out.

For assistance with the preparation of this issue, thanks to the computer team – Alistair Evans and Anne Morton. Thanks also to Felicity Garde (label printing) and Michael McBain (web page).

Dawn Till Dusk: In the Stirling and Porongurup Ranges

by Rob Olver and Stuart Olver

Publisher: *Tuart House, 1998. 176 pp. RRP $45 hard cover, $34 paper cover.*

'Dawn Till Dusk is both a practical guide to, and a visual celebration of, the Stirling and Porongurup Ranges of South-western Australia.' This quote from the press release is an accurate description of this wonderful book. The photography, mostly done by Rob Olver, is enough to make you want to pack your bags and catch the first flight to W.A. Des Olver also supplies a stunning shot of a Western Grey Kangaroo in the Stirling Range heathland.

The book covers such topics as: detailed information of natural history, bushwalks, climbs, special attractions, gliding, flying, wineries, scenic drives, facilities and accommodation.

Chapter one gives a little of the known Aboriginal history. Chapter two gives a more detailed and well-researched record of early European history. Then follow chapters on: geology, climate, flora and fauna and some very useful maps for the future travellers of this magnificent area.

I was pleased to read in Chapter five, on the subject of mammals, that control of feral cat and fox populations need to be addressed before the re-introduction of some of the diminishing mammal species.

The topic of environmental weeds is touched upon; this and the feral animal problems faced by most land managers is often omitted from books of this nature. Also, the authors highlight the serious effects of *Phytothphora cinnamomi*, the fungus which has devastated many W.A. forests. A Management Plan has been prepared for the Stirling Range and at present twenty-five percent of the park is closed to all users on a seasonal basis. C.A.L.M. is also carrying out research on threatened and priority listed flora in the Stirling Ranges.

There are 123 species of the Orchidaceae family found in the Stirling Range, 38% of all known orchids in Western Australia. As all the flowers in previous chapters give common and scientific names, I wondered why the authors did not do the same for the orchids that were mentioned in the text. I realise many are undergoing revision, but would have still liked the current name included.

Bridal Creeper is also mentioned as a problem weed in the Stirlings. This is a common name for a highly invasive weed and once again I would have liked the scientific name to clarify what plant the authors were referring to. Was the plant *Myrsiphyllum asparagoides*? Bridal Veil and Bridal Creeper are common names used by the nursery trade and sold to the unwary.

The authors state that in the Porongurup Range, 300 varieties of fungi grow. I would suggest that there are many more, but was interested that a count of species has taken place as like the non-vascular plants (mosses, lichens and liverworts) they are sometimes overlooked when Flora and Flora are being compiled.

The chapter on scenic drives will be useful for visitors planning a trip to the two parks, but it is the bushwalking chapters that are exceptional, their enthusiasm for these two magnificent areas is apparent. Rob and Stuart have gone to great detail to explain the way to really see these two areas on foot. Maps are excellent throughout the whole book including this chapter. The rock-climbing information is given in the same detail with stunning photos of some challenging climbs.

I highly recommend this very well researched and beautifully photographed book and congratulate the authors for sharing their vast knowledge on the Stirling and Porongurup Ranges. The book is an absolute must for any traveller planning to explore these two ranges in the future.

Cecily Falkingham
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Intertidal Sighting of *Stiliger smaragdinus* Baba 1949 – an Uncommon Mollusc

During the late morning of 23 February 1999, at Kitty Miller Bay, Phillip Island, a single *Stiliger smaragdinus* was sighted in the lowermost intertidal zone during the spring low tide. This is an opisthobranch mollusc in the Order Sacoglossa (see Burn 1998). It was exposed to air on a flat rock that was situated between two rockpools rich in the seaweeds *Caulerpa cactoides* and *Amphibolis antarctica*. The day was warm but overcast.

The mollusc was placed in a plastic container of seawater; it then expanded and began to move about. The estimated length was 5 cm. The specimen was a beautiful lime green with delicate yellow and bluish-white colouration at the bases of the cerata and across the bodies of some of them. The numerous cerata waved about like algal fronds when the water column was disturbed. The photograph below shows the elevated pericardium on the dorsum of the mollusc, with the anal opening as a raised white papilla just anterior to it (see Burn 1998). After photography, the specimen was left in the adjacent rockpool on a frond of *C. cactoides*. When the spot was revisited half an hour later, the mollusc had not moved from its position.

Stiliger smaragdinus is found in Japan, the western Pacific, around Australia and also in New Zealand (Burn 1998), to depths of 22 m (Edgar 1997). It feeds on green algae and, when sighted, is often associated with *C. cactoides* (Edgar 1997). The species attains lengths of up to 75 mm (Burn 1998; Edgar 1997).

Acknowledgements

I thank the Marine Research Group for their eager support, particularly Clarrie Handreck for his enthusiasm, Robert Burn for identifying the mollusc, and both of these and Ken Bell for valuable comments on an earlier draft of this note.

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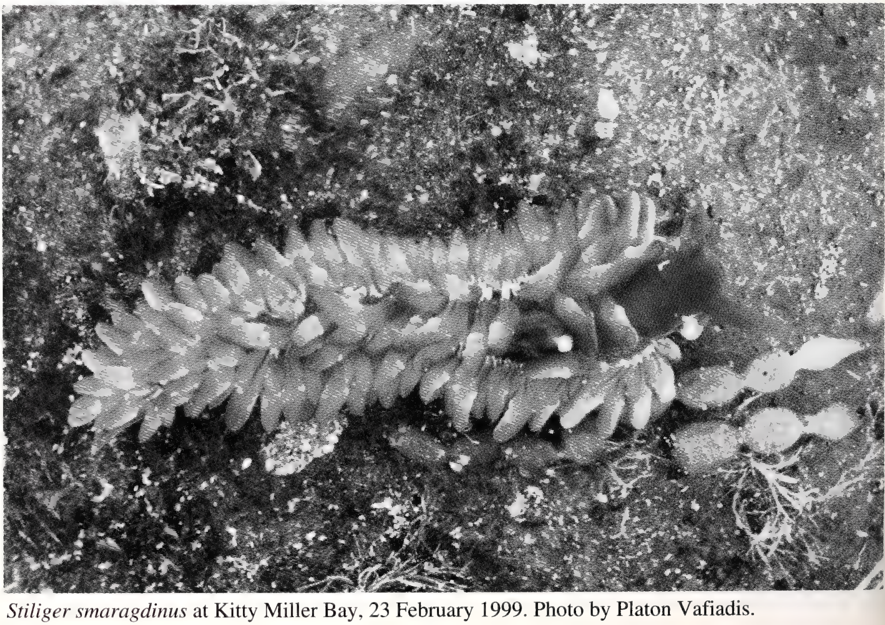

Stiliger smaragdinus at Kitty Miller Bay, 23 February 1999. Photo by Platon Vafiadis.

The Victorian Naturalist

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Cover: The Common Brushtail Possum *Trichosurus vulpecula* in the Fitzroy Gardens, Melbourne, eating bread left by tourists. (See Research Report, p. 120.) Photo by Kelly Miller.

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Attitudes Towards Possums: a Need for Education?

Kelly K. Miller[1], Peter R. Brown[1] and Ian Temby[2]

Abstract
When dealing with wildlife-human conflict issues, social considerations are as important as biological and ecological considerations to the successful implementation of management strategies. This study investigated the human dimensions of the human-possum conflict, by asking people in an urban area of Melbourne for their views and knowledge of possums. The survey found that although factual knowledge of possums within the community is generally low, residents are keen to learn more about possums. It also found that respondents with a high knowledge of possum biology had a more positive attitude towards possums than respondents with a comparatively low level of knowledge. These findings suggest that further community education on this issue is warranted. (*The Victorian Naturalist* **116** (4), 1999, 120-126).

Introduction

Although research into the human dimensions of wildlife management is well advanced in North America, it is still in its infancy in Australia (Jones 1993). North American studies over the last two to three decades suggest that an understanding of the human component of wildlife management issues is crucial to the effective implementation of management strategies. As Pomerantz *et al.* (1987: 357) explain, 'understanding the public's needs and concerns and communicating the rationale for agency programs back to the public are necessary steps to achieving management objectives'. This understanding is particularly important for wildlife-human conflicts such as those arising from the cohabitation of people and possums in urban areas.

Two species of possum commonly cohabit with humans in the urban, suburban and rural areas of Australia: the Common Ringtail Possum *Pseudocheirus peregrinus* and the Common Brushtail Possum *Trichosurus vulpecula*. Both species are protected in the State of Victoria under the *Wildlife Act* 1975.

While the Common Ringtail Possum can create problems for residents, such as damage to garden plants (McKay and Ong 1995; Temby 1992) and aesthetic problems (e.g. droppings on driveways), it is the Common Brushtail Possum that causes most concerns. The Common Brushtail Possum is nocturnal and spends the day in a den in a hollow branch, tree trunk, fallen log or, with increasing urbanisation, in the roof cavity of a house (How and Kerle 1995). The occupation of house roof cavities by members of this species is common in many urban areas of Australia and is the primary cause of conflict between humans and possums (How 1992).

Problems associated with the Common Brushtail Possum include noise, damage to the house, damage to garden plants, aesthetic problems, and potential health risks.

1. Noise from possum movement (in the ceiling and on the roof) and possum calls can present problems for residents. Indirect noise problems can also occur when domestic dogs bark at possums during the night.
2. Damage to the house can include urine stains and holes in the ceiling and walls.
3. Damage to garden plants can result when possums defoliate native and ornamental trees and shrubs and eat vegetables, fruit and flowers.
4. Aesthetic problems can occur when there is possum odour, droppings on driveways or urine stains on cars.
5. Potential health risks can cause concern for residents (e.g. loss of sleep due to noise).

In order to better understand the dynamics of the urban possum issue, the aim of this study was to investigate what people in an urban area feel (attitudes) and know (knowledge) about possums and explore the link between the two.

Methods

The City of Knox, a group of suburbs located approximately 25 km east of the Melbourne Central Business District, was chosen as the study site. This site contains

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highly vegetated areas (particularly in those areas abutting the Dandenong Ranges National Park) through to residential areas with little vegetative cover. It was therefore considered to be representative of a range of different types of urban areas.

A nine-page questionnaire was mailed, in 1995, to 500 adult residents (randomly selected using publicly available ratepayers books) throughout the City of Knox, of whom 142 residents responded (28%). A limited time-frame did not allow follow-up of non-respondents, and the sample (referred to as the Resident Sample) was considered to be an adequate size for the exploratory nature of the study. Twenty-one percent of respondents were 18-30 years of age, 42% were 31-45 years of age, 23% were 46-60 years of age, 14% were over the age of 60 years; and 70% of the sample was female.

Accompanying the questionnaire was a covering letter and reply-paid envelope. The covering letter introduced the study to potential respondents and emphasized anonymity and confidentiality of responses. Respondents were given the option of including their name and contact details on the questionnaire for any future studies but were not required to do so. Respondents indicating interest in the survey results were mailed a summary of the research at the conclusion of the study.

The questionnaire included 44 questions on a number of topics including attitudes towards possums, human-possum conflicts, knowledge of possums, management issues and demographic characteristics of respondents.

In addition to the Resident Sample, 50 members of local special interest groups and other stakeholders were interviewed by telephone. These groups included the Knox Environment Society, Ferntree Gully Residents' Action Group, Ferntree Gully Horticultural Society, residents who had recently hired possum traps from the Knox City Council, Wildlife Shelters/Wildlife Foster-carers, and Veterinary Surgeons. The telephone interviews focussed on the same topics as the questionnaire, but allowed for further discussion on certain points.

Both quantitative and qualitative data analysis techniques were used. For quantitative data, descriptive and inferential statistics (two-sample z test (Moore and McCabe 1993)) were used with comparative data statistically significant at $p \leq 0.05$. For qualitative data, open-ended questions were analysed for key themes and important comments. These components of the data are illustrated using direct quotes from respondents.

Results and Discussion

Respondent attitudes towards possums were assigned to three main categories based on answers to several questions including 'how would you describe your overall view of possums?' and 'why do you hold this view?' The attitude categories were:

1. Positive attitude, where the respondent indicated that possums were welcome at the house or property;
2. Negative attitude, where the respondent indicated that possums were a nuisance or pest; and
3. Neutral attitude, where the respondent indicated an undecided opinion.

From the Resident Sample (n = 142), 25.4% of respondents expressed a positive attitude towards possums, 33.1% expressed a negative attitude towards possums, 37.3% expressed a neutral attitude towards possums, and 4.2% of respondents did not complete the attitude questions.

Five questions were used to test the knowledge level of the resident in terms of possum biology. Fifteen percent of the respondents from the Resident Sample who completed the knowledge questions (n = 137) answered all five questions correctly, and 10% displayed a low knowledge level answering either no questions correctly or one question correctly. The proportion of the Resident Sample that answered each of the five knowledge questions correctly is shown in Table 1.

The poor knowledge of possum biology in the Resident Sample was also apparent in the special interest group samples, with small proportions completing all knowledge questions correctly. Five of the 10 Knox Environment Society respondents answered all five knowledge questions correctly, compared with three of the seven responding Veterinary Surgeons,

Table 1. Proportion of Resident Sample that answered knowledge questions correctly.

Knowledge question	**Response categories**	**Proportion that answered correctly (%) (n = 137)***
A full-grown Brushtail Possum is smaller than a full-grown Ringtail Possum	true/false/unsure	26.1
Ringtail Possums usually have a white tip on their tail.	true/false/unsure	34.1
Possums are nocturnal.	true/false/unsure	92.8
A marsupial is:	a nocturnal animal/a mammal with a pouch/a mammal without a pouch	91.3
Tick those of the following that are marsupials:	dog/fox/possum/dolphin/ kangaroo	73.2

* Five questionnaire respondents did not answer the knowledge questions and were excluded from this analysis.

three of the 10 Ferntree Gully Residents' Action Group respondents, three of the 10 Ferntree Gully Horticultural Society respondents, one of the 10 trap-hirers, and all three Wildlife Shelters/Wildlife Foster-carers. Of particular interest was the poor knowledge shown by the responding Veterinary Surgeons, which was surprising given the relative simplicity of the knowledge questions.

Another indication of poor knowledge can be seen in the responses to the question that asked what species of possum was present around respondents' homes. Of the 55 respondents from the Resident Sample who believed they had possums around the house or property, 65% were unsure of the species.

There was a clear correlation between attitudes towards possums and knowledge levels of possum biology. Sixty percent of those respondents with a high level of possum knowledge (n = 20), defined as answering all knowledge questions correctly, held a positive attitude towards possums. In comparison, only 7% of those respondents with a low level of possum knowledge (n = 14), defined as no knowledge questions answered correctly or one knowledge question answered correctly, held a positive attitude towards possums (two-sample z test: $z = 3.13$, $p = 0.001$).

This trend was also observed in the Special Interest Group samples. Respondents from the Knox Environment Society and Wildlife Shelters/Wildlife Foster-carers held mainly positive attitudes towards possums and had predominantly high knowledge levels, when compared with respondents from the trap-hirers group (residents who had recently hired possum traps from the Knox City Council) and the Ferntree Gully Horticultural Society. The latter two groups held mainly negative attitudes towards possums and had comparatively low knowledge levels (Fig. 1).

A similar correlation was noted by Schulz (1987) in a study of adult students' attitudes towards wildlife in West Germany. Schulz found that knowledge level was the best variable to explain different scores on the attitude scale. Schulz's study, based on the value framework developed by Kellert (1976), showed that respondents with a very high knowledge level also had high values on the moralistic, naturalistic, ecologistic, and scientistic attitude scales. Conversely, respondents with a very low knowledge level had high values on the humanistic, negativistic, and utilitarian attitude scales.

Although Schulz's study (1987) had more detailed attitude categories than our study, the results are similar. Respondents to our questionnaire who had a high knowledge of possums displayed characteristics consistent with the moralistic, naturalistic, ecologistic and scientistic attitudes as described by Kellert and Berry (1987). These respondents typically held positive attitudes towards possums, with sentiments such as:

I appreciate wildlife.
Possums are a natural part of the

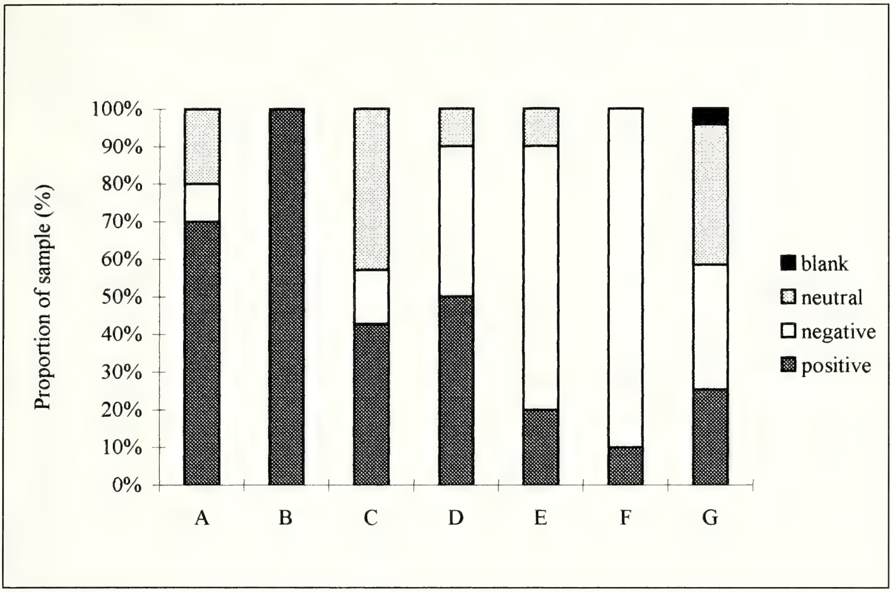

Fig. 1. Attitudes towards possums in Special Interest Group and Resident samples (statistical analysis could not be conducted due to small sample sizes).
A = Knox Environment Society (*n* = 10), B = Wildlife Shelters/Wildlife Foster-carers (*n* = 3), C = Veterinary Surgeons (*n* = 7), D = Ferntree Gully Residents' Action Group (*n* = 10), E = Ferntree Gully Horticultural Society (*n* = 10), F = Trap-hirers (*n* = 10), G = Resident Sample (*n* = 142)

Australian environment and we should learn to live with them.

I am an animal lover and enjoy seeing possums in my garden.

I love animals and wildlife.

We like a bush environment and enjoy all native animals.

It is good for the kids to experience animals and learn to live with them.

They were here long before us and I believe all native fauna should be preserved.

In comparison, typical answers from respondents with a low knowledge level included:

[my view is] based on friends' experiences with possums doing damage to their houses.

... we had possums... noisy, vermin, destroyers, and their dropping mess everywhere.

People live in houses with family and pets. The bush is provided (and there is plenty of it in Victoria) that possums can live in without causing problems in roof, fireplace etc.

This correlation between knowledge of possums and attitudes towards possums raises an important question that could be explored by future research – which comes first, the positive attitude or the high knowledge level? That is, does a person with a positive attitude towards possums have more interest and therefore seek out information, or does the increased information or factual knowledge result in the positive attitude? To investigate this question, attitudes could be assessed before and after an education program (focusing only on factual knowledge and not information that could directly influence attitudes) specifically relating to urban possums.

Other studies have indeed shown that public values either change or can be changed with better information (Stucky *et al.* 1987). A preliminary study by Caro *et al.* (1994) found that in a short period of time, education in conservation biology (via an undergraduate university course) made students more biocentric. Although this indicates that education may be an effective management tool in modifying attitudes towards nature, it may be that stu-

dents seeking out an environmental course already have positive attitudes towards the environment. The education they choose may simply strengthen the attitudes that they already have and encourage them to clearly express those attitudes. In order to explore this further, education could be targeted at those people within the community with negative attitudes towards possums in order to determine if education is effective in modifying their attitudes.

Implementing education programs also requires an understanding of what people wish to learn about. From our survey, 30.4% of respondents (n = 138) said they would like to learn about 'possum ecology/biology', 40.6% said they would like to learn about 'how to live with possums', 26.1% said they would like to learn 'how to remove possums' and 26.8% said they would like to learn about 'what happens to translocated possums'. Table 2 divides these findings further into those respondents with a positive attitude towards possums and those respondents with a negative attitude towards possums.

Respondents with a positive attitude towards possums were significantly more interested in learning about possum ecology and biology and how to live with possums, than those respondents with a negative attitude towards possums (Table 2). In contrast, those respondents with a negative attitude towards possums were significantly more interested in learning about how to remove possums, than those respondents with a positive attitude (Table 2).

As respondents with negative attitudes towards possums were shown to be less interested in learning about possums, it may prove more difficult to change their attitudes (through education) into positive attitudes. Thus, education of children (rather than adults) may be more effective in modifying and/or shaping attitudes, because the attitudes of children are still forming. Similarly, Caro *et al.* (1994) speculated that conservation education may be more effective in changing attitudes when people are exposed to it at an early age. Other studies have also shown that a person's childhood experiences with animals are important factors in the development of adult attitudes towards wildlife (Hair and Pomerantz 1987).

Although a change in attitudes towards wildlife can be achieved (Temby 1995), it has been suggested by Baldwin (1995) that a change in attitude is not enough. Baldwin (1995) said 'while basic classroom education can be effective at changing values and attitudes toward nature, direct experience has the powerful effect of changing behaviour' (p. 241). In our study, the most common factor contributing to the respondents' knowledge of possums in the Resident Sample was 'personal experience' (49%). One current possum education program in our study area incorporates 'basic classroom education' with 'personal experience' by showing the class a possum and allowing interaction (Y. Cowling *pers.com.*). Although this program focuses on childhood education, the experience of actually seeing a native animal will undoubtedly have an impact on many children and possibly instil a positive value of wildlife within them. However, further research would be required to confirm whether or not a change in attitude would lead to a change in behaviour on this issue.

While childhood education is important, information must also be available to adults. The fact that 40.6% of respondents from the Resident Sample indicated they would like to learn how to live with possums, clearly indicates the need to educate the general public – to inform residents of urban areas how to cohabit successfully with possums, or at least inform them that 'harmonious' cohabitation is possible and has many advantages.

As Temby (1995: 178) has suggested for the management of kangaroos, 'acceptance and use of alternative approaches that do not rely on destruction will only come about through appropriate extension programmes that demonstrate their effectiveness and economic benefits'. Similarly, residents with possum problems must be informed of appropriate and effective management techniques. Residents will have little hope of effectively resolving a conflict if they do not have the appropriate information that will allow them to do so. The recent distribution of the 'Living With Possums' booklet[1] (Department of Natural Resources and Environment 1997) to key groups in Victoria, such as local councils and wildlife shelters, will undoubtedly

Table 2. Respondent attitudes (Resident Sample) versus aspects of possum ecology/biology and management the respondent would like to learn about.

Option respondent would like to learn about	Proportion of 'positive attitude towards possums' subgroup (%) (n = 36)	Proportion of 'negative attitude towards possums' subgroup (%) (n = 47)	Significance (two-sample z test) z	p
Possum ecology/biology	64	19	4.17	0.000
How to live with possums	61	30	2.83	0.002
How to remove possums	17	51	3.20	0.001
What happens to translocated possums	33	23	1.01	0.156
Other	6	0	[1]	[1]
One or more of the above	94	79	1.95	0.026

[1] Statistical analysis could not be conducted due to small sample sizes.

increase many residents' knowledge of possums, particularly those who are having possum problems.

Conclusion

This study has demonstrated that members of the community, including special interest groups, generally have a poor knowledge of possum biology. The study also showed that there is an important link between attitudes towards possums and knowledge of possums, that people within the community are interested in learning about possums and that people with a positive attitude towards possums are more interested in learning more about possums than those with a negative attitude. These findings support the suggestion that communication and education programs are important aspects of wildlife management (Peyton and Decker 1987; Penland 1987). The key requirement highlighted by this study is the need for community education. As well as providing basic information (via government agencies and community groups) to those who have problems with possums, it is also important that the broader community is given the opportunity to learn more about and experience not only possums but all native wildlife.

Acknowledgements

We would like to thank the School of Ecology and Environment at Deakin University for financial support of this study. Special thanks go to Dr Tara McGee (Deakin University), Professor Robert Wallis (Deakin University), Dr Darryl Jones (Griffith University), and Ms Leoni Thomas (Griffith University), for critical comments on earlier versions of this manuscript and invaluable discussions on wildlife-human conflicts in Australia; Ms Yvonne Cowling (wildlife shelter operator) for providing information on her wildlife shelter and school education program; Ms Rhonda Miller (wildlife shelter operator) for helpful proof-reading and insightful comments; and all questionnaire and interview participants from the City of Knox.

[1] The 'Living With Possums' booklet can be obtained by contacting the Flora and Fauna Branch, Department of Natural Resources and Environment (250 Victoria Parade, East Melbourne, 3002), or the RSPCA (3 Burwood Highway, Burwood East, 3151).

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Mother and baby Common Brushtail Possum *Trichosurus vulpecula* feeding. Supplementary feeding of possums and other wildlife is a common, though not recommended, practice. Photo by Rhonda Miller.

A New Inland Record of the Swamp Skink *Egernia coventryi* Storr, 1978

Nick Clemann[1] and Cam Beardsell[1]

Abstract
The threatened Swamp Skink *Egernia coventryi* occupies a predominantly coastal distribution in south-eastern Australia. Few inland records exist from western Victoria. This note reports a new inland record of *E. coventryi* from the vicinity of Ballarat. This population was located in habitat considered somewhat atypical for this species. (*The Victorian Naturalist* **116** (4), 1999, 127-128).

The Swamp Skink *Egernia coventryi* is listed as vulnerable in Victoria (NRE 1999) and has a disjunct distribution in southeastern Australia, predominantly in coastal regions (Cogger 1996). Within this range this lizard occupies swamp and saltmarsh habitat characterised by dense sedge and tussock vegetation (Smales 1981; Schulz 1985; Clemann 1997). Due to the structure of this vegetation, and the retiring nature of this lizard, *E. coventryi* is difficult to capture by hand and is more reliably collected using Elliott aluminium traps (Robertson 1980; Clemann 1997).

Egernia coventryi is known from only a small number of inland locations, generally in eastern Victoria at Yellingbo and in East Gippsland (Atlas of Victorian Wildlife database, NRE). There are also inland records for the west of the State, from the Casterton district, the Grampians National Park, and a single historical record from Ballarat. Despite recent searches, the population in the Grampians has not been observed for some time (J. Coventry *pers. comm.*). The details of the record from Ballarat, including collection date and specific locality, are incomplete and unsubstantiated.

While conducting herpetofauna surveys for the Regional Forest Agreement process during January 1999 in the Enfield State Forest (143° 45' E, 37° 44' S), approximately 20 km southwest of Ballarat, one of the authors (NC) observed what was suspected to be an adult individual of *E. coventryi* in a low-lying area at the headwaters of a drainage line. In an effort to confirm this identification, 25 Elliott traps were positioned in the vicinity of the original sighting on 9 February 1999, and baited with pilchards, a proven bait for this species (Clemann *et al.* 1998).

[1] Arthur Rylah Institute for Environmental Research, Department of Natural Resources and Environment, 123 Brown Street, Heidelberg, Victoria 3084.

The vegetation in the immediate vicinity of the traps was heathy woodland dominated by Prickly Tea-tree *Leptospermum continentale* and Dwarf Bush-pea *Pultenaea humilis* with an open overstorey of Messmate *Eucalyptus obliqua,* Scent-bark *E. aromaphloia* and Shining Peppermint *E. willisii.* Co-dominant vegetation in the ground layer included Small Grass-tree *Xanthorrhoea minor,* Common Rapier-sedge *Lepidosperma filiformis,* Many-flowered Mat-rush *Lomandra multiflora,* Slender Tussock-grass *Poa tenera* and Slender Dodder-laurel *Cassytha glabella.*

The following morning the traps were checked and yielded a single adult female *E. coventryi* and two Agile Antechinus *Antechinus agilis.* The lizard was gravid and produced four young on 14 February 1999 while it was temporarily captive. The length and weight of the adult and the neonates are presented in Table 1. All animals were released where caught after suitable observations had been made and photographs taken (Fig. 1).

A brief survey of the immediate area revealed a number of sympatric scincid species, including White's Skink *Egernia whitii,* Southern Water Skink *Eulamprus tympanum,* Garden Skink *Lampropholis guichenoti* and Eastern Three-lined Skink *Bassiana duperryi.*

It is interesting to note that, despite its proximity to a major town, this population of *E. coventryi* has previously gone undetected. The habitat at this site is uncharacteristic for *E. coventryi* in that it has an overstorey of *Eucalyptus* spp., and contains no *Melaleuca* spp., usually evident in this skink's habitat.

Table 1. Length and weight data of adult female and four neonate *Egernia coventryi* from Enfield State Forest.

	Weight (g)	Snout-vent length (mm)	Tail length (mm)
Adult female	16.5	90	92 original plus 36 regrown
Juvenile 1	1.0	37	48
Juvenile 2	0.9	34	44
Juvenile 3	0.9	36	44
Juvenile 4	1.0	37	48

Acknowledgements

The authors thank Richard Loyn and Graeme Newell from the Arthur Rylah Institute, Department of Natural Resources and Environment, for encouraging the confirmation of the original tentative sighting. John Coventry (Curator of Herpetology at the Museum of Victoria) and Peter Robertson provided helpful comments on the distribution of this species. Peter also kindly measured and weighed the lizards. Geoff Brown, Richard Loyn and Graeme Newell commented on the manuscript. The authors thank an anonymous referee for reviewing the manuscript. The surveys were funded by State and Commonwealth Governments as part of the process of developing the Regional Forest Agreements.

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Fig. 1. *Egernia coventryi*, gravid female, Enfield State Forest. Photo by Nick Clemann.

The Use of 'Forms' for Denning by the Common Ringtail Possum *Pseudocheirus peregrinus* at Subalpine Altitudes

Ken Green[1]

Abstract
Daytime observations of Common Ringtail Possums on the ground in subalpine woodland are attributed to the use of forms, similar to those used by hares. These areas of flattened vegetation are used both in summer and in winter, when they are found beneath the snow. (*The Victorian Naturalist* **116** (4), 1999, 129-130).

The local abundance of Common Ringtail Possums *Pseudocheirus peregrinus* is thought to be affected by the availability of nest sites (McKay 1983). The nest is usually a ball of grass or shredded bark in a hollow limb or amongst dense foliage, but at the northern extent of the range of the species a nest is rarely constructed, although the possum still sleeps in tree hollows (McKay 1983). In stands of regrowth Snowgum *Eucalyptus niphophila* above 1500 m in the Snowy Mountains, relatively few trees have had sufficient time to develop hollows, but Ringtail Possums may still be observed (Green and Osborne 1994).

In February 1999, Ringtail Possums were disturbed on the ground in snowgum woodland on Disappointment Spur at about 1:30–2:00 pm by Glenn Sanecki (*pers. comm.*) and two days later at 9 am by the author. In the first case, the possum was simply disturbed as the observer walked through thick woodland, so no deductions could be made about its behaviour on the ground. Because the Ringtail Possum is strictly nocturnal (McKay 1983) this is, however, indicative of behaviour other than foraging. In the second instance, the author had spent some minutes within one metre of a Ringtail Possum while handling two captured Dusky Antechinuses *Antechinus swainsonii*. It wasn't until the animals had been released, equipment packed away and traps folded that the author, stepping over a leaning tree, disturbed the possum which quickly ran up a nearby tree. On investigation, there was no evidence of a ground-level nest. However, beneath a tree and under a nearby grass tussock there was evidence of flattening of the herbaceous stratum in what could best be described as a minimalist 'form', similar to that used by Hares *Lepus capensis* in long grass, rushes or heath (Hewson 1977, Mahood 1983). Denning in such a 'form' by Ringtail Possums has not previously been recorded in the literature but their occurrence on the ground in the late afternoon has also been observed in woodland at Mt. Kaputar (Bill Foley *pers. comm.*) and at Round Mountain (Will Osborne *pers. comm.*)

The use of 'forms' by Ringtail Possums in winter is even more unexpected, although conditions beneath the snow may be more comfortable than in a drey situated in thick scrub, a sight uncommon above the winter snowline (Green and Osborne 1994). Generally mammals weighing more than 250 g are rare beneath the snow surface (Pruitt 1984) except in the case of burrowers and/or hibernators, which in Australia include the Fox *Vulpes vulpes* and Common Wombat *Vombatus ursinus* (Green and Osborne 1994) and Echidna *Tachyglossus aculeatus* (Grigg *et al.* 1992).

In mid July 1996, in an area with no old Snowgums, the author observed a Ringtail Possum at 9.20 am emerging from a possum-width tunnel chewed through thick shrubs leading to below the snow surface. The site was marked, and investigated after the thaw. All that was present at the site was a branch of down-turned gum leaves about 40-50 cm off the ground, with a space beneath but no evidence of a nest. This form was more protected than Hare forms in winter which are sometimes no more than a scrape beneath an overhanging tree (*pers. obs.*). Extensive movement under the snow would be impossible for

[1] NSW National Parks and Wildlife Service, Snowy Mountains Region, PO Box 2228, Jindabyne NSW 2627.

such a large non-burrowing mammal as a Ringtail Possum and their tracks are seldom recorded on the snow (*pers. obs.*), so their normal behaviour would probably be to descend a tree directly to their 'form'.

In a sample of 1159 fox scats from a subalpine transect containing many Hares, evidence of Hares was only found in one scat while remains of Ringtail Possums were found in five. Compared with nine occurrences of Rabbits *Oryctolagus cuniculus*, which are less common than either species above the winter snowline (Green and Osborne 1994), these figures are quite low. This suggests that, unless the Rabbits were scavenged after dying for some other reason, denning on the ground is not as dangerous as it might first appear, as long as an animal has some well-developed predator-avoidance mechanism such as speed (in the case of the Hare) or tree-climbing (in the Ringtail Possum). The greater degree of protection afforded to a Ringtail Possum in winter by submerging itself completely beneath the snow may be an indication of a low tolerance of cold. Comparative studies on the thermal biology of Ringtail Possums and Hares have not been conducted. However, the non-burrowing Hare (Mahood 1983) is able to survive heavy snow years without moving to lower altitudes, both in New Zealand (Flux 1967) and Australia, and without being forced to enhance its insulation from the cold by using the space beneath the snow.

Based on the observations reported here, it appears possible that the use of 'forms' by Ringtail Possums may be widespread but infrequently noted. The occurrence of this behaviour at subalpine altitudes raises interesting questions about the thermal biology of the species, particularly in winter.

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Editor's note:
Hewson (1977) describes a hare's form as 'a shallow depression in long grass, rushes, heather or scrub'.

Fifty Years Ago

MONTHLY NOTES FROM THE PORTLAND F.N.C.

by Noel F. Learmonth

Among the exhibits brought to our last meeting were two Rufous Bristle-birds (*Dasyornis broadbenti*), a Ground Thrush (*Oreocincla lunulata*), a Goshawk (*Astur fasciatus*) and an Allied Rat (*Rattus assimilis*) - all from among that morning's catch in a member's line of rabbit traps. Bristle-birds are frequently killed in this way and, though difficult to see in the thick undergrowth south of Portland, are quite common; the writer saw five birds on one bush track at Cape Nelson recently. Ground Thrushes are rare here, though widespread. The goshawk was only just dead when found at dawn, so it must be a very early hunter.

From *The Victorian Naturalist* **66**, p. 68, August 1949.

Fauna Survey Group (FSG) Contribution No. 22

A Survey of the Vertebrate Fauna of the Rushworth State Forest

S.D. Myers[1] and S.G. Dashper[1]

Abstract
Surveys were conducted in the Rushworth State Forest by the Fauna Survey Group of the FNCV for about four years. The main motivation for the work was to detect and monitor the presence of Brush-tailed Phascogale *Phascogale tapoatafa*, but we have also kept records for all vertebrate species detected. These records include a number of species that are declining, threatened or endangered and provide a picture of the current status of the fauna in the forest. (*The Victorian Naturalist*, **116** (4), 1999, 131-141).

Introduction

Box and Ironbark forests contain some of the most threatened habitats in Victoria. Approximately 85% of these forests and related ecosystems have been cleared since pre-European settlement and less than 3% of that remaining receives any form of protection (Robinson 1993). A large proportion of the Box-Ironbark forests in Victoria now exist only in fragmented and degraded remnants. This has had a considerable, deleterious effect on the fauna of these woodlands and forests. Since European settlement, three groups of species in particular (Bennett 1993) have declined in the Box-Ironbark forests. These are 1) the hollow-dependent species requiring large areas (e.g. Powerful Owl *Ninox strenua*, Brush-tailed Phascogale *Phascogale tapoatafa*, Squirrel Glider *Petaurus norfolcensis*); 2) mobile species that utilise resources in different locations (e.g. Little Lorikeet *Glossopsitta pusilla*, Swift Parrot *Lathamus discolor*, Regent Honeyeater *Xanthomyza phrygia*); and 3) forest-dependent species that utilise fallen logs and ground litter for nesting, foraging and shelter (e.g. Hooded Robin *Melanodryas cucullata*, Bush Stone-curlew *Burhinus magnirostris*). A range of activities such as mining, timber cutting and land clearing within the Box-Ironbark forests has led to a reduction in the resources required by these groups.

The Rushworth State Forest is the largest, most intact block of Box-Ironbark forest remaining in this State. It is located in north central Victoria and lies approximately 23 km north-east of Heathcote and 12 km west of Nagambie, covering an area of *circa* 32 630 ha (Environment Conservation Council 1997). Within the forest, conservation reserves include the Mount Black Flora Reserve (1630 ha) and the Whroo Historic Reserve (490 ha). The remaining forest area is classified as State Forest for hardwood production (Land Conservation Council 1981).

The terrain is generally flat to undulating, gentle hills with Mount Black being the highest peak at 328 m. There are many creeks throughout the Rushworth State Forest that rarely flow except during periods of heavy rain. Annual rainfall varies from 400–700 mm (Land Cconservation Council 1981). The Rushworth-Whroo area was a major goldfield last century; the forest has been seriously damaged in the past by the activities of gold miners. To this day evidence of these past activities is quite visible. The forest is still heavily used for logging and firewood collection. Timber is extracted by selective logging and permit holders may take firewood. Certain areas of the State Forest have not had as many trees removed; consequently the number of hollow-bearing trees is higher in these areas (*pers. obs.*). The forest is also used for a number of recreational activities such as fossicking, rally car driving, trail biking and horse riding.

Vegetation

There are a number of vegetative structural forms within the forest as classified by the Land Conservation Council (1981) and the Environment Conservation Council (1997). (See also Muir *et al.* (1995) for a description of EVCs (Ecological Vegetation Classes) for this area.) The general vegetative structure is

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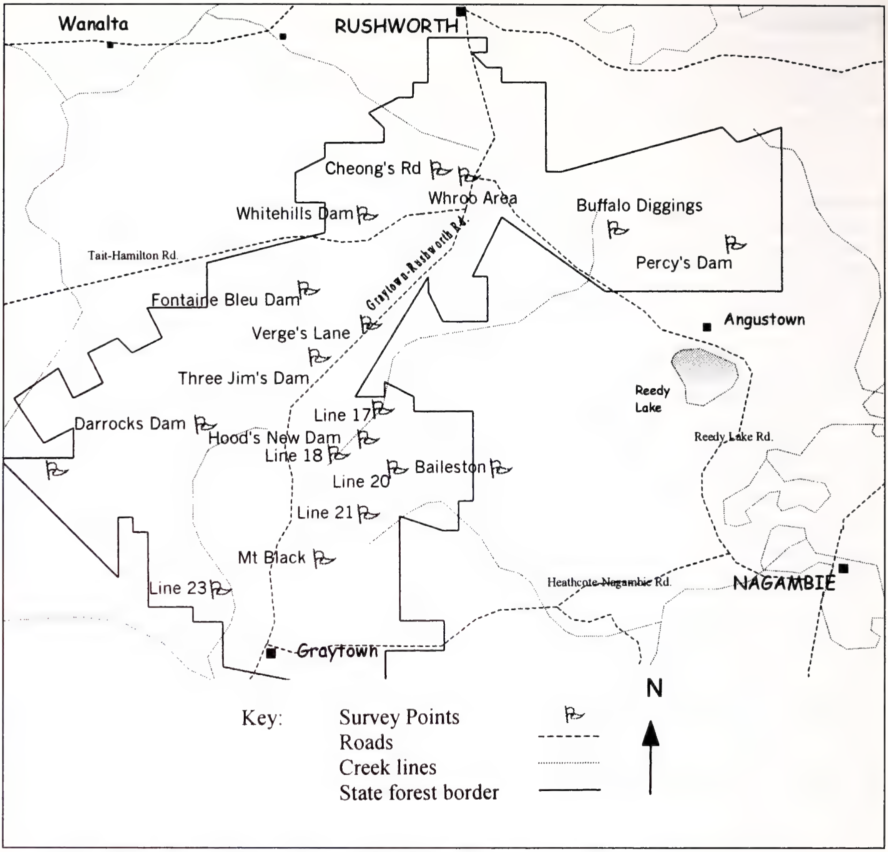

Fig. 1. Major survey points in Rushworth State Forest. (Scale 1 km = 3.2 mm approximately)

classified as Open Forest II where Red Ironbark *Eucalyptus tricarpa*, Grey Box *Eucalyptus microcarpa* and Yellow Gum *Eucalyptus leucoxylon* are the dominant species of the tallest stratum (Land Conservation Council 1978). The lower strata consist of Gold-dust Wattle *Acacia acinacea*, Hedge Wattle *A. paradoxa*, Chinese Tea-tree *Cassinia arcuata* and Austral Grass-tree *Xanthorrhoea australis*. Austral Grass Trees are especially conspicuous around the slopes of Mount Black. In addition to the above forest type, large areas of Open Forest I consisting of Red Ironbark, Red Stringybark *E. macrorhyncha* and Red Box *E. polyanthemos* are also extant. Patchy areas of Open Forest I Woodland I, where the major tree species are Grey Box and Yellow Gum, and Open Scrub of Bull Mallee *E. behriana* and Blue Mallee *E. polybractea*, are also found within the State Forest (Land Conservation Council 1978). Most of the Open Scrub mallee in the northern section of the forest is used for Eucalyptus-oil production. Altered fire regimes combined with invasion by introduced herbaceous species has changed the forest's substrata since historic times.

The Fauna Survey Group (FSG) of The Field Naturalists Club of Victoria has been conducting fauna surveys in the Rushworth State Forest since the beginning of 1995 with particular emphasis on determining the status and distribution of the Brush-tailed Phascogale *Phascogale tapoatafa* (Dashper and Myers *in prep.*). This report serves to catalogue records of all vertebrate species recorded by the FSG in the region over the past four years.

Table 1. Total survey effort by the FSG in Rushworth State Forest.

Survey date	No. of nest boxes checked	Trap nights	Spotlighting (minutes)	Bat trapping (nights)
June 94	-	240	330	3
December 94	-	776	405	-
April 95	-	220	-	-
Dececember 95	92	210	105	1
April 96	12	-	-	-
May 96	142	-	-	-
September 96	28	-	30	-
January 97	142	100	-	-
June 97	142	200	160	-
July 97	-	-	190	-
January 98	142	80	95	1
May 98	92	30	180	-
Total	**792**	**1856**	**1495**	**5**

Survey Methods and Results

Fauna surveys have been conducted over a period of three and a half years from 1995 to 1998. Surveys were carried out every 4 to 6 months at various locations throughout the forest (Fig. 1). A variety of survey techniques were used including checking nest boxes, trapping, spotlighting, bird observations and incidental sightings. Table 1 shows the survey effort for each technique.

Nest boxes

A total of 142 nest boxes were routinely checked including 92 nest boxes originally erected in 1992 (Soderquist *et al.* 1996) and 50 nest boxes erected by the FSG in 1995. The 92 nest boxes are at 23 sites consisting of four nest boxes along a transect, the boxes each approximately 100 m apart. The 50 nest boxes erected by the FSG are in lines of 10 boxes, at five sites in the central section of the forest. All nest boxes have entrance holes of 35 mm in diameter, which is a size thought to favour Brush-tailed Phascogales and Sugar Gliders *Petaurus breviceps* (Soderquist *et al.* 1996). Therefore, nest box usage may not be an actual reflection of the status and distribution of mammals other than phascogales and Sugar Gliders.

Table 2 shows the number of records and occupancy rates for each species observed using the nest boxes. By far the most commonly recorded species was the Sugar Glider, followed by the Brush-tailed Phascogale. Only five species in total have been recorded using the nest boxes; of those, two have been recorded only once each and one has been recorded twice. Sugar Gliders had a significantly higher nest box occupancy rate than the Brush-tailed Phascogale, the next most commonly recorded species.

Trapping

Cage and Elliott traps were set in lines of 10 traps about 10 m apart. The bait used was a mixture of peanut butter, rolled oats, honey and vanilla essence. Trapping was not carried out during the phascogale breeding season from August to December or during particularly cold weather.

A small effort at pitfall trapping was made during a single visit in December 1994 to January 1995. One pitline with 10 buckets spaced at 10 m intervals was opened for 5 nights. Unfortunately, no animals were trapped by this method.

Spotlighting

Spotlighting was carried out on a regular, but not intensive, basis by members during FSG camps in a number of areas, mainly in the central south section of the forest (Table 3). It was carried out on an opportunistic basis and usually conducted by two groups of two to six people walking at a pace of approximately 3 km/h.

Bat trapping

Bat trapping was carried out using harp traps and trip lines (Table 1). Further surveys of bats in the area are required.

Bird records

A bird list was maintained during each of the eighteen mammal survey trips as well as during some independent trips by the authors (survey trips were up to four days in length). Observations were made throughout the forest (Fig. 1); while carrying out other survey efforts, all birds seen and heard were recorded.

Table 2. Species recorded in nest boxes (Total No. = number of individuals recorded) and occupancy rate (Occ. Rate = no. species records/no. boxes checked). Key: BTPh , Brush-tailed Phascogale; SG, Sugar Glider; YFA, Yellow-footed Antechinus; CBP, Common Brushtail Possum; CRT, Common Ringtail Possum.

Date	BTPh	SG	YFA	CBP	CRT
Dec-95	1	25	1		
Apr-96	1	18			
May-96	4	93		1	
Sep-96	1	34			
Jan-97	6	62	1		1
Jun-97	4	114			
Jan-98	4	76			
May-98	1	68			
Total No.	**22**	**490**	**2**	**1**	**1**
Occ. Rate	0.03	0.77	0.01	0.01	0.01

Table 3. Spotlighting results. Mean Spotlighting Rate (MSR) = No. of records/total spotlighting time (minutes); No. = Number of records. *see discussion.

Species	No.	MSR
Australian Owlet-nightjar	1	0.04
Barn Owl	1	0.04
Brush-tailed Phascogale	1	0.04
Common Brushtail Possum	21	0.84
Common Ringtail Possum	19	0.76
Feathertail Glider	1	0.04
Koala	1	0.04
Southern Boobook	3	0.12
Squirrel Glider	8 *	0.32
Sugar Glider	36	1.44
Tawny Frogmouth	1	0.04

Chance observations and indirect signs

Vocalisations, scats and tracks encountered were duly noted.

Discussion

Survey work by the FSG in the Rushworth State Forest area is an ongoing process that we hope to continue for many years to come. This is an interim report of survey records to date. The group has recorded a number of species that are of particular interest.

The aim of trapping by the FSG at Rushworth was chiefly to detect the presence of phascogales. Therefore, we have generally employed the strategy of setting traps in seemingly suitable habitat, especially near hollow stumps and logs and at the base of hollow-bearing trees. Trapping has been a rather selective process, however this has not excluded other mammals such as the Yellow-footed Antechinus *Antechinus flavipes* from being trapped. To date, trapping in Rushworth has not been particularly successful, highlighting the trap shyness of the animals combined with low densities of phascogales and other small mammals in this Box-Ironbark forest.

Mammals

The following is an annotated list of mammals recorded in the Rushworth State Forest by the FSG over the past four years. Mammals in the forest were detected by means of trapping, spotlighting and by indirect and chance observations (vocalisations, scats, tracks). Measures of abundance (Tables 2 and 3) are given for mammals that were recorded by trapping, spotlighting or nest box checks.

Short-beaked Echidna *Tachyglossus aculeatus*

One direct sighting of a very large, pale individual was recorded with signs of diggings reasonably common although not widespread. Despite the apparent abundance of ants in the forest, echidnas do not seem to be common; it is possible that the very hard soil limits the ability of the species to exploit this food source.

Yellow-footed Antechinus *Antechinus flavipes flavipes*

The Yellow-footed Antechinus was recorded using nest boxes, in traps and through incidental observations during the day. Scats and nests in nest boxes are also reasonably common. This indicates that it is a relatively common species in the Rushworth Forest.

The Yellow-footed Antechinus is restricted to a band running roughly along the line of the Great Dividing Range from the north-east to the south-west of the State where it occurs mainly in dry forest and woodland. This species is heavily reliant on natural tree hollows for shelter (Menkhorst 1995). Naturally occurring ground litter and logs, where the Yellow-footed Antechinus forages for arthropods and small vertebrates, are also necessary. Menkhorst (1995) states that the degradation of the dry woodland habitats of this species inevitably leads to

concern over its long-term survival prospects.

Brush-tailed Phascogale *Phascogale tapoatafa*

The most significant mammal recorded is the Brush-tailed Phascogale. The phascogale is classified as rare in Victoria by the Department of Natural Resources and Environment and listed in Schedule 2 of the Fauna and Flora Guarantee Act. This species was first recorded by others in 1993 when phascogale nests and scats were recorded in nest boxes, although no animals were sighted (Soderquist *et al.* 1996). The FSG has 22 records in total of phascogales using nest boxes (Table 2). *Phascogale tapoatafa* has been observed twice during spotlight surveys and recorded three times in traps. Additionally, signs, including scats and nests, have been noted in 28 of 142 nest boxes (19%) regularly checked by the FSG. Obviously use of nest boxes by the Brush-tailed Phascogale is considerably lower than that of the Sugar Glider but we believe that even this low occupancy rate is important. The phascogale requires large areas of forest in order to maintain viable populations (Soderquist 1995). A lack of mature-age, hollow-bearing trees may lead to phascogales selecting hollows with inadequate protection against predators, leading to an increase in mortality rates. As the Box-Ironbark forest continues to be degraded and fragmented, local extinctions are likely to occur. Rushworth State Forest is the largest block of Box-Ironbark forest remaining in Victoria, and is important for the conservation of this species. With the erection of nest boxes in the Rushworth State Forest it is possible we are encouraging the phascogale population to increase in number, as a lack of hollows limits populations.

Common Dunnart *Sminthopsis murinus*

One female with 5 pouch young was trapped in tall open woodland grading to low open woodland in the southern end of the forest. In Victoria the Common Dunnart's status is uncertain (Menkhorst 1995), it is classified as Rare by the Environment Conservation Council (1997). Rushworth may possibly represent an important population.

Koala *Phascolarctos cinereus*

One Koala was recorded while spotlighting in the Spring Creek area in the southern section of the forest.

Common Brushtail Possum *Trichosurus vulpecula*

Menkhorst (1995) records the Common Brushtail Possum as common in Box and Ironbark forests. They were the second most commonly observed species after the Sugar Glider during spotlighting (MSR 0.84 *cf.* 1.44; Table 3). One was recorded in a decrepit nest box.

Sugar Glider *Petaurus breviceps*

The Sugar Glider was the most frequently recorded mammal. Its use of nest boxes appears to be mostly in areas with low densities of hollow-bearing trees. It was the most frequently observed species when spotlighting (Table 3).

This species is widespread and relatively common in Victoria and its status is classified as secure (Menkhorst 1995). The Sugar Glider is also dependent on tree hollows. The extremely high rate of nest box usage by Sugar Gliders (Table 2) may indicate a paucity of natural hollows. We often found Sugar Gliders using nest boxes in areas that are almost totally devoid of hollow-bearing trees. Lunney (1987) found that in forests such as Rushworth State Forest that are managed intensively as a timber resource leading to reduced numbers of hollow bearing trees, Sugar Glider numbers are consequently reduced. In the Rushworth area large stands of coppiced eucalypts have replaced much old-growth forest, leading the fauna survey group to suspect that the species' future in the Rushworth area is by no means secure.

Squirrel Glider *Petaurus norfolcensis*

This species was observed in an area of roadside vegetation consisting of some large hollow-bearing Yellow Box on the southern border of the forest. It is possible that this species has been recorded during spotlighting in the Spring Creek area but due to difficulties with identification of the Squirrel Glider (Traill 1998) further work is required in order to confirm the existence of this species within the Rushworth State Forest. Sherwin (1996) classifies the Rushworth forest

block as a key location for this species.

Common Ringtail Possum
Pseudocheirus peregrinus

The Common Ringtail Possum was recorded once while using a nest box which was in very poor condition. The animal gained access to the box via the broken lid. This species was recorded many times in edge habitat during spotlighting but rarely within the forest.

This species is common in forested areas in Victoria but it appears that in Rushworth State Forest it uses hollows rather than dreys for nesting. A lack of hollows in the area may lead to reduced numbers in Rushworth State Forest.

Feathertail Glider *Acrobates pygmaeus*

One Feathertail Glider was recorded by the group while it was foraging in a large flowering Yellow Gum near a dam. This species has only been recorded once in the Rushworth State Forest in 1990 (Atlas of Victorian Wildlife database, NRE). It may be under reported due its diminutive size.

Eastern Grey Kangaroo *Macropus giganteus*

This species is common throughout the forest, particularly in areas abutting farmland. It is commonly recorded by direct observation and signs such as scats and skeletal remains.

Black Wallaby *Wallabia bicolor*

The Black Wallaby is one of the most common mammals observed throughout Rushworth State Forest. It is frequently sighted while driving, walking and spotlighting. Road kills are also commonly observed. The thumping, warning sound is frequently noted, as are scats. Young animals are also often seen, suggesting a high breeding rate.

Gould's Wattled Bat *Chalinolobus gouldii*

One Gould's Wattled Bat was captured in a harp trap.

Little Forest Bat *Vespadelus vulturnus*

The Little Forest Bat was recorded from harp trapping in the central section of the forest. The species is common and widespread in Victoria (Menkhorst 1995).

Red Fox *Vulpes vulpes*

Four sight records of foxes were made within the forest. Scats are regularly, though not commonly, noted. Anecdotally, this species does not appear to be common in Rushworth State Forest.

Cat *Felis catus*

We have one sight record of a cat, and scats have been noted on occasions. It does not appear to be common in the forest.

Goat *Capra hircus*

We have no direct sightings of Goat. Tracks and scats have been recorded in the central section of the forest. What is believed to be goat hair has been observed in phascogale nests. Tracks have been noted at some dams.

Feral Pig *Sus scrofa*

The group has one record of a dead pig near Spring Creek in the southern end of the forest.

European Rabbit *Oryctolagus cuniculus*

Sight and sign records were frequently made. Anecdotally, we have noted a decrease in abundance since the introduction of the Calicivirus.

Birds

Over 100 species of bird have been recorded by the FSG, with approximately 30 days of bird observations of varying intensity being carried out. This represents a rich avifauna. Table 4 shows a list of bird species recorded by the FSG in the Rushworth State Forest. Measures of abundance are given for birds where reporting rate and abundance were measured. A number of species recorded by the FSG in Rushworth State Forest are classified by the Department of Natural Resources and Environment as depleted. These are: Collared Sparrowhawk, Wedge-tailed Eagle, Little Lorikeet, Australian Owlet-nightjar, White-bellied Cuckoo-shrike, Jacky Winter, Crested Bellbird, Spotted Quail-thrush, White-browed Babbler, Speckled Warbler, Chestnut-rumped Heathwren, Grey Currawong and Emu (see also Robinson 1994). Water birds such as herons and cormorants have been recorded at numerous dams scattered through the forest. Most dams are man-made for fire-fighting purposes. Interesting sightings are discussed below.

Emu *Dromaius novaehollandiae*

An artificially established population at Puckapunyal Military Reserve (Emison

et al. 1987) was the only record for central Victoria collected over the period from 1977 to 1981. This leads the FSG to believe that the Emu has possibly spread to the Rushworth State Forest. Our percentage-reporting rate of 22.2% suggests that the species has possibly become well established in the area although no signs of breeding have yet been observed.

Little Lorikeet *Glossopsitta pusilla*

This species mainly inhabits Box-Ironbark and associated forest but is not common in the Rushworth region. Little Lorikeets are highly nomadic and have been recorded by the group when eucalypts are flowering in spring and winter. It is also declining in Victoria (Robinson 1994).

Swift Parrot *Lathamus discolor*

Classified as Vulnerable and listed under Schedule 2 of the Flora and Fauna Guarantee Act 1998, the Swift Parrot relies on winter-flowering eucalypts in its non-breeding range, such as are found in the Box-Ironbark forests.

Powerful Owl *Ninox strenua*

The Powerful Owl has been recorded once by the group in an area abutting Mount Black where larger, hollow bearing trees remain in reasonable numbers. It has been estimated that fewer than 500 breeding pairs remain in Victoria (Garnett 1992). It is estimated by the Environment Conservation Council (1997) that fewer than 50 breeding pairs remain in the Victorian Box-Ironbark forests. Rushworth State Forest could therefore be an important area for the conservation of this species. The Powerful Owl is classified as rare and vulnerable in Australia and Victoria, although widespread (Environment Conservation Council 1997).

Yellow-rumped Pardalote *Pardalotus punctatus xanthopygus*

The Yellow-rumped Pardalote was only ever observed in the mallee area in the north of the forest. This is probably an isolated population and may hybridise with the more commonly occurring nominate race, Spotted Pardalote *Pardalotus punctatus punctatus*.

Chestnut-rumped Heathwren *Hylacola pyrrhogia*

We have found this species to be locally common within the Rushworth State Forest, although it is declining in Victoria (Robinson 1994).

Speckled Warbler *Chthonicola sagittata*

This species is classified as declining by Robinson (1994); it is a ground feeding and nesting species that is particularly vulnerable to introduced predators. The Speckled Warbler's main distribution in southeastern Victoria is within the dry Box forests and woodlands. Where the habitat is highly modified or disturbed (e.g. where timber cutting occurs as in Rushworth) the populations disappear (Robinson and Traill 1996).

Regent Honeyeater *Xanthomyza phrygia*

The Regent Honeyeater is listed as a threatened taxon in Schedule 2 of *the Flora and Fauna Guarantee Act 1988* and classified as Endangered by the Department of Natural Resources and Environment. This species has declined in or disappeared from much of its range. Its present population may be less than 1000 individuals, and its decline is believed to be due to habitat loss, degradation and fragmentation (Garnett 1992).

Tawny-crowned Honeyeater

This species was recorded only in areas of mallee near the town of Rushworth in the northern section of the forest.

Black Honeyeater *Certhionyx niger*

A single bird was observed drinking at a dam in January 1995 after a period of below average rainfall. Rushworth forest may represent an important drought refuge area for such species. The importance of these sites to species such as Black Honeyeater, in terms of long-term viability, requires further research (Ford and Paton 1986) especially in view of continuing fragmentation of dry woodland habitats.

Red-capped Robin *Petroica goodenovii*

The Red-capped Robin is classified as declining in Victoria (Robinson 1994). It appears to be uncommon in Rushworth State Forest.

White-browed Babbler *Pomatostomus superciliosus*

The White-browed Babbler is declining in Victoria (Robinson 1994), and although not uncommon in Rushworth, anecdotally we have noted a decrease in numbers. The White-browed Babbler

Table 4. Birds Recorded in Rushworth State Forest. Surveys = number of survey trips in which the species was detected out of 18 carried out; % = percentage of surveys on which the species was recorded. Common and scientific names follow Christidis and Boles (1994).

Common Name	Scientific Name	Surveys	%
Emu	*Dromaius novaehollandiae*	4	22.2
Brown Quail	*Coturnix ypsilophora*	2	11.1
Australian Wood Duck	*Chenonetta jubata*	3	16.7
Pacific Black Duck	*Anas superciliosa*	4	22.2
Australasian Grebe	*Tachybaptus novaehollandiae*	5	27.8
Pied Cormorant	*Phalacrocorax varius*	1	5.6
Great Cormorant	*Phalacrocorax carbo*	1	5.6
White-faced Heron	*Egretta novaehollandiae*	2	11.1
White-necked Heron	*Ardea pacifica*	1	5.6
Nankeen Night Heron	*Nycticorax caledonicus*	1	5.6
Brown Goshawk	*Accipiter fasciatus*	4	22.2
Collared Sparrowhawk	*Accipiter cirrhocephalus*	1	5.6
Wedge-tailed Eagle	*Aquila audax*	4	22.2
Little Eagle	*Hieraaetus morphnoides*	1	5.6
Peregrine Falcon	*Falco peregrinus*	1	5.6
Painted Button-quail	*Turnix varia*	4	22.2
Common Bronzewing	*Phaps chalcoptera*	12	66.7
Brush Bronzewing	*Phaps elegans*	2	11.1
Crested Pigeon	*Ocyphaps lophotes*	3	16.7
Galah	*Cacatua roseicapilla*	12	66.7
Sulphur-crested Cockatoo	*Cacatua galerita*	11	61.1
Rainbow Lorikeet	*Trichoglossus haematodus*	1	5.6
Musk Lorikeet	*Glossopsitta concinna*	12	66.7
Little Lorikeet	*Glossopsitta pusilla*	9	50.0
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	4	22.2
Crimson Rosella	*Platycercus elegans*	17	94.4
Eastern Rosella	*Platycercus eximius*	15	83.3
Swift Parrot	*Lathamus discolor*	1	5.6
Pallid Cuckoo	*Cuculus pallidus*	2	11.1
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	3	16.7
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	4	22.2
Horsfield's Bronze-Cuckoo	*Chrysococcyx basilis*	2	11.1
Powerful Owl	*Ninox strenua*	1	5.6
Southern Boobook	*Ninox novaeseelandiae*	4	22.2
Tawny Frogmouth	*Podargus strigoides*	1	5.6
White-throated Nightjar	*Eurostopodus mystacalis*	2	11.1
Australian Owlet-nightjar	*Aegotheles cristatus*	5	27.8
White-throated Needletail	*Hirundapus caudacutus*	5	27.8
Laughing Kookaburra	*Dacelo novaeguineae*	13	72.2
Sacred Kingfisher	*Todiramphus sanctus*	3	16.7
Rainbow Bee-eater	*Merops ornatus*	2	11.1
White-throated Treecreeper	*Cormobates leucophaeus*	15	83.3
Brown Treecreeper	*Climacteris picumnus*	10	55.6
Superb Fairy-wren	*Malurus cyaneus*	12	66.7
Spotted Pardalote (includes Yellow-rumped Pardolote)	*Pardalotus punctatus*	16	88.9
Striated Pardalote	*Pardalotus striatus*	12	66.7
Chestnut-rumped Heathwren	*Hylacola pyrrhopygia*	3	16.7
Speckled Warbler	*Chthonicola sagittata*	2	11.1
Weebill	*Smicrornis brevirostris*	14	77.8
Western Gerygone	*Gerygone fusca*	1	5.6
Brown Thornbill	*Acanthiza pusilla*	1	5.6
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	2	11.1
Buff-rumped Thornbill	*Acanthiza reguloides*	16	88.9
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	4	22.2
Yellow Thornbill	*Acanthiza nana*	2	11.1
Striated Thornbill	*Acanthiza lineata*	4	22.2
Red Wattlebird	*Anthochaera carunculata*	18	100.0
Little Wattlebird	*Anthochaera chrysoptera*	1	5.6

Table 4. continued.

Common Name	**Scientific Name**	**Surveys**	**%**
Noisy Friarbird	*Philemon corniculatus*	3	16.7
Little Friarbird	*Philemon citreogularis*	1	5.6
Regent Honeyeater	*Xanthomyza phrygia*	1	5.6
Noisy Miner	*Manorina melanocephala*	3	16.7
Yellow-faced Honeyeater	*Lichenostomus chrysops*	7	38.9
White-eared Honeyeater	*Lichenostomus leucotis*	11	61.1
Yellow-tufted Honeyeater	*Lichenostomus melanops*	18	100.0
Yellow-plumed Honeyeater	*Lichenostomus ornatus*	3	16.7
Fuscous Honeyeater	*Lichenostomus fuscus*	17	94.4
White-plumed Honeyeater	*Lichenostomus penicillatus*	8	44.4
Black-chinned Honeyeater	*Melithreptus gularis*	8	44.4
Brown-headed Honeyeater	*Melithreptus brevirostris*	17	94.4
White-naped Honeyeater	*Melithreptus lunatis*	5	27.8
New Holland Honeyeater	*Phylidonyris novaehollandiae*	5	27.8
Tawny-crowned Honeyeater	*Phylidonyris melanops*	3	16.7
Eastern Spinebill	*Acanthorhynchus tenuirostris*	4	22.2
Black Honeyeater	*Certhionyx niger*	1	5.6
White-fronted Chat	*Epthianura albifrons*	1	5.6
Jacky Winter	*Microeca fascinans*	3	16.7
Scarlet Robin	*Petroica multicolor*	6	33.3
Flame Robin	*Petroica phoenicea*	5	27.8
Red-capped Robin	*Petroica goodenovii*	1	5.6
Rose Robin	*Petroica rosea*	1	5.6
Hooded Robin	*Melanodryas cucullata*	1	5.6
Eastern Yellow Robin	*Eopsaltria australis*	7	38.9
White-browed Babbler	*Pomatostomus superciliosus*	9	50.0
Spotted Quail-thrush	*Cinclosoma punctatum*	3	16.7
Varied Sittella	*Daphoenositta chrysoptera*	2	11.1
Crested Shrike-tit	*Falcunculus frontatus*	4	22.2
Crested Bellbird	*Oreoica gutturalis*	9	50.0
Gilbert's Whistler	*Pachycephala inornata*	1	5.6
Golden Whistler	*Pachycephala pectoralis*	8	44.4
Rufous Whistler	*Pachycephala rufiventris*	9	50.0
Grey Shrike-thrush	*Colluricincla harmonica*	12	66.7
Satin Flycatcher	*Myiagra cyanoleuca*	1	5.6
Restless Flycatcher	*Myiagra inquieta*	4	22.2
Magpie-lark	*Grallina cyanoleuca*	3	16.7
Grey Fantail	*Rhipidura fuliginosa*	11	61.1
Willie Wagtail	*Rhipidura leucophrys*	8	44.4
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	10	55.6
White-bellied Cuckoo-shrike	*Coracina papuensis*	2	11.1
White-winged Triller	*Lalage sueurii*	1	5.6
Olive-backed Oriole	*Oriolus sagittatus*	9	50.0
Black-faced Woodswallow	*Artamus cinereus*	1	5.6
Dusky Woodswallow	*Artamus cyanopterus*	10	55.6
Grey Butcherbird	*Cracticus torquatus*	1	5.6
Australian Magpie	*Gymnorhina tibicen*	10	55.6
Pied Currawong	*Strepera graculina*	5	27.8
Grey Currawong	*Strepera versicolor*	16	88.9
Australian Raven	*Corvus coronoides*	13	72.2
Little Raven	*Corvus mellori*	2	11.1
White-winged Chough	*Corcorax melanorhamphos*	15	83.3
Diamond Firetail	*Stagonopleura guttata*	1	5.6
Mistletoebird	*Dicaeum hirundinaceum*	3	16.7
Welcome Swallow	*Hirundo neoxena*	4	22.2
Tree Martin	*Hirundo nigricans*	4	22.2
Silvereye	*Zosterops lateralis*	4	22.2
Common Blackbird	*Turdus merula*	1	5.6
Common Starling	*Sturnus vulgaris*	2	11.1

previously occurred in the Geelong area but now only occurs north of the Great Dividing Range in Victoria.

Spotted Quail-thrush *Cinclosoma punctatum*

The Spotted Quail-thrush is declining in Victoria (Robinson 1994) and was observed infrequently by FSG members.

Crested Bellbird *Oreoica gutturalis*

This species is fairly widespread, though not common in the Rushworth State Forest. Since the local extinction of this species in the Chiltern forest (Traill *et al.* 1996), the Rushworth population possibly represents the easternmost population in Victoria and is likely to be an important population at the outer limit of the birds' south-eastern distribution.

Grey Currawong *Strepera versicolor*

Although declining in Victoria (Robinson 1994), this species is fairly common in Rushworth State Forest.

Herpetofauna (Tables 5 and 6).

No systematic surveys for reptiles and amphibians have been carried out to date. However, casual observations have revealed a number of species. In particular Bibron's Toadlet *Pseudophryne bibronii* and Eastern Banjo Frog *Limnodynastes dumerelli* are common around dams within the forest. Given that these dams are relatively recent, man-made additions to the landscape it seems likely that populations of these species have increased since historic times. Both *Varanus varius* and *V. gouldii* have been observed on one occasion. They require hollow logs and dense litter for shelter. Both of these commodities have been depleted in Box-Ironbark forests since European settlement.

Conclusion

The Fauna Survey Group has recorded a number of species that fall within the three groups of declining species described by Bennett (1993). The relative paucity of records for many of these species suggests that a lack of large hollow bearing trees has had an impact on the distribution and abundance of these species. Other disturbances in the Rushworth State Forest have led to a decline in species reliant on fallen and rotting logs and a deep litter layer.

Unfortunately, the Box-Ironbark forests of Victoria have, in the past, fallen victim to an unglamorous image. In large part the forest was all but destroyed before people had a chance to realise its intrinsic value (Calder *et al.* 1994). Compared to the wet forests of Victoria, dry forests have received little attention in recent years. The importance of this type of forest to Australia's history and ecology cannot be overstated. An increase in awareness of conservation issues in regard to biodiversity has recently helped to overcome some of these problems but ongoing effort is required. Many species rely wholly or in large part on the Box-Ironbark forest. In order to protect biodiversity in this State the protection of Box-Ironbark forest is of tantamount importance.

The Fauna Survey Group is continuing its work in the Rushworth State Forest in the hope that a picture can be created of the fauna in this area in regard to status, distribution and occurrence. We will continue to place emphasis on the Brush-tailed Phascogale as we believe this species to be not only of particular intrinsic interest but an indicator of the overall health of the forest. At the same time we will of course keep records of all species detected.

Table 5. Amphibians recorded at Rushworth State Forest. Common and scientific names follow Cogger (1996).

Common Name	Scientific Name
Common Froglet	*Crinia signifera*
Eastern Smooth Frog	*Geocrinia victoriana*
Eastern Banjo Frog	*Limnodynastes dumerili*
Bibron's Toadlet	*Pseudophryne bibronii*
Southern Brown Tree Frog	*Litoria ewingii*
Peron's Treefrog	*Litoria peronii*

Table 6. Reptiles recorded at Rushworth State Forest. Common and scientific names follow Cogger (1996).

Common Name	Scientific Name
Marbled Gecko	*Christinus marmoratus*
Tree Dragon	*Amphibolurus muricatus*
Gould's Monitor	*Varanus gouldii*
Lace Monitor	*Varanus varius*
Bougainville Skink	*Lerista bougainvillii*
South-eastern Morethia	*Morethia boulengeri*
Common Bluetongue	*Tiliqua scincoides*
Red-bellied Black Snake	*Pseudechis porphyriacus*
Eastern Brown Snake	*Pseudonaja textilis*

Acknowledgements

The Fauna Survey Group would particularly like to thank the M.A. Ingram Trust for financial support with this survey. The authors wish to express their gratitude to Ray Gibson, Rob Gration, Russell Thompson and Ray White, as well as all FSG members who assisted with fieldwork. Trapping was carried out under Research Permit number RP-97-144 under the provisions of the Wildlife Act 1975. We would like to thank an anonymous referee for helpful comments on the draft of this paper.

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One Hundred Years Ago

A Large Dingo - I wish to bring under the notice of this Club particulars regarding a large half-bred Dingo killed recently at Tatong, about 20 miles south-east of Benalla. A paragraph in the Age of 24th April last stating that a Dingo a shade over 6 feet long had been captured at Tatong, struck me as being very interesting, on account of the size of the animal, and I accordingly made inquiries on the matter. Mr. Z. Anthony, of the Vermin Destruction Branch of the Department of Lands and Survey, kindly wrote to Mr. M.J. Delahenty, the Vermin Inspector of the Benalla district, who replied that the animal was a half-bred Dingo, black in colour, and nearly as large as a Newfoundland dog. As this is a most unusual size, even for a half-bred wild dog, the fact appears worthy of record. - A.E. Kitson, 10th July, 1899.

From *The Victorian Naturalist* **XVI**, p. 76, August 1899.

Moss Bed Lake on the Nunniong Plateau

R.J. Fletcher[1]

Abstract
A pristine sphagnum bog on the Nunniong Plateau is visited and a start is made to determine the suite of plants that furnish it. (*The Victorian Naturalist* **116** (4), 1999, 142-145).

A network of tracks of varying quality, virtually all of them created for logging, covers the Nunniong Plateau in Gippsland. On the one hand this has destroyed much of the habitat, but on the other has made a rather remote area accessible.

Many of these tracks have fascinating names, such as Jam Tin, Blue Shirt, Diggers Hole and so on. Following an excursion to Brumby Point in April 1998, we took some time to examine some of the tracks and follow a circuit beginning at Brumby Point Track, then along Diggers Hole Road to Wheatfield Road and to Ryans Creek Road, which comes to a dead end at Ryan Creek below Mount Nunniong. A short distance further along Wheatfield Road there is the Missing Link, less than a kilometre long, which connects with Moss Bed Track. Along Moss Bed Track, about 1.25 km short of its intersection with Mellick Munjie Road, and just to the south, there is an expanse, quite circular, of water forming a sphagnum bog and bordered by a eucalypt forest. It is marked on the Deception-Deddick 8523-N Mapsheet, co-ordinates EU953906 and accessible by a track from the Moss Bed Track.

The winter and spring of 1997 were particularly dry, and followed by a hot summer, so that when we first saw the 'Lake' it was in fact a completely dry vista of dried *Sphagnum* moss extending over the whole bed, which is about 300 m in diameter. Clumps of dried rushes broke the monotony (Fig. 1). Time was not available to make any real examination, but having established the locality we determined to come back at another time, preferably after rain. In a normal or average year this alpine area, altitude approximately 1180 m, could expect a rainfall of between 1000 to1400 mm (Bureau of Meteorology). In addition to this precipitation there would be runoff from higher country, much of the surrounding area, particularly to the west, being in excess of 1300 m. Characteristically, the

Fig. 1. Moss Bed Lake. Dry in April 1998.

alpine bog community occurs on a more or less impervious clay or peat (Ashton and Hargreaves 1983). This particular bog would appear to be on the latter base, and possibly also with a granite underlay. This observation is made because the area surrounding the Lake is covered with decaying granite in pieces up to football size. The soil depth is not very great and this is easily observed from the root structure of fallen trees.

Substantial timber surrounds the Lake, including Mountain Gum *Eucalyptus dalrympleana*, Messmate *E. obliqua* and Narrow-leaf Peppermint *E. radiata*. Not far away, within a kilometre and within earshot, one could hear the chainsaws and bulldozers clear-felling. In addition to this destruction, the tracks had been widened to allow for the passage of timber jinkers, by the simple expedient of bulldozing the margin of Moss Bed Track. This road widening technique can also be observed on other parts of the Nunniong Plateau, noteably along Nunniong Road, so timber extraction is set to continue for some time yet. Huge areas have been clear-felled along Mellick Munjie Road and also further west in the Emu Plains area west of

[1] 28 Marjorie Avenue, Belmont 3216.

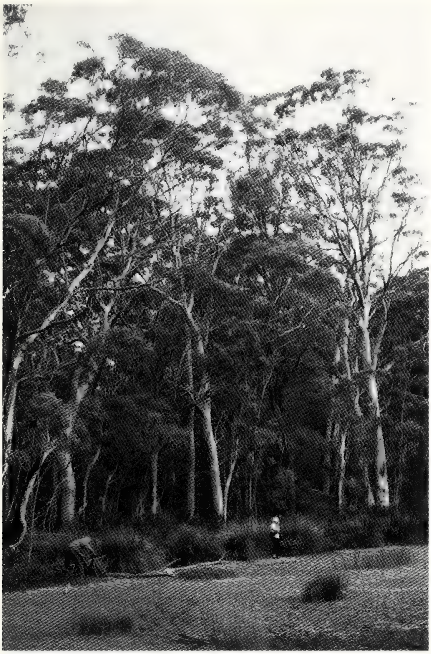

Fig. 2. A border of *Gahnia sieberiana* separates Moss Bed Lake from a stand of *Eucalyptus dalrympleana.*

the Nunniong Road. In this area, the unwanted logs have been piled into extensive windrows in preparation for burning. So much for the uses of the forest.

The good rains early in 1999, breaking the long drought, encouraged us to revisit Moss Bed Lake and the marked difference can be seen in Fig. 2. This picture illustrates well the abrupt demarcation from bog to timber, with a substantial intervening border of Red-fruit Saw-sedge *Gahnia sieberiana* between the Lake and a stand of Mountain Gum. Much of the foreground in Fig. 2 is occupied by a dense mat, with the common name of Marshwort *Nymphoides montana,* growing in shallow water. The handsome golden-yellow flowers of this aquatic plant make a marvellous mass display under these conditions, as soon as the sun has risen sufficiently high (Fig. 3).

Apart from the extensive sheets of Marshwort, and the general distribution of *Sphagnum* over most of the area, the bog is dominated by clumps of Mountain Cord-rush *Restio australis* (Fig. 4), whose flowering heads make quite a splendid

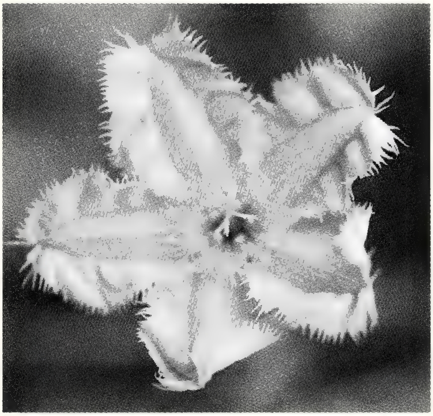

Fig. 3. Flower of *Nymphoides montana* opened up by the warmth of the sun.

show. Another dominant plant is the Tall Spike-rush *Eleocharis sphacelata*, which tends to grow in separate stands. Specimens of this plant growing near the margin of the Lake had been grazed by brumbies. We in fact observed a small mob doing just this on the western side of the Lake. We later found it was a spot where they commonly came to drink. To obtain an illustration of the flowering spike (Fig. 5) it was necessary to rather gingerly walk some distance out on a fallen log, the only alternative to wading waist deep.

Keeping just clear of the *Sphagnum* moss it was possible to walk more or less dryshod around the Lake, although close to the margin there were tracks through the moss where brumbies and wombats had been foraging or drinking. In this wet area between the open water and the beginning of the forest occur many rushes and sedges, and Table 1 contains a list of those we were able to identify. Also in this wet area there were Alpine Water-fern *Blechnum penna-marina*, Bat's Wing Fern *Histiopteris incisa* and lots of Chickweed

Table 1. Some Rushes and Sedges at Moss Bed Lake.

Carex appressa	Tall Sedge
C. gaudichaudiana	Fen Sedge
C. jackiana	Sedge
Eleocharis sphacelata	Tall Spike-sedge
Empodisma minus	Spreading Rope-rush
Gahnia sieberiana	Red-fruit Saw-sedge
Juncus subsecundus	Finger Rush
Luzula modesta	Southern Woodrush
Restio australis	Mountain Cord-rush

Fig. 4. Mountain Cord-rush *Restio australis* clumps at Moss Bed Lake.

Stellaria media. In some of the wetter spots were mats of the Small River Buttercup *Ranunculus amphitrichus*. Within a few metres of the margin, making an understorey of the eucalypts already mentioned, there is a wide variety of herbs and shrubs. River Lomatia *Lomatia myricoides* was just beginning to flower, although at lower altitudes we saw many in full flower. Cinquefoil Cranes-bill *Geranium potentilloides* made a splash of colour here and there as did the Alpine Podolobium *Podolobium alpestre* and Grass Trigger-plant *Stylidium graminifolium*, and some clumps of Golden Everlasting *Bracteantha bracteata*. Twining its way through some of the shrubs was Purple Appleberry *Billardiera longiflora* (Fig. 6).

More time and expertise would be required to make a complete census of the plants growing in and around Moss Bed Lake, but Table 2 contains a list of those identified during or since the excursion.

Acknowledgements
Thanks to Ken Hollole and Dagmar Savva for their company and assistance, and especially to John Reid and Helen Aston of the National Herbarium of Victoria for the identification of *Carex appressa* and *Nymphoides montana* respectively.

Table 2. Some Dicotyledons in and around Moss Bed Lake (* = introduced).

Acacia mearnsii	Black Wattle
A. siculiformis	Dagger Wattle
Acaena novae-zelandiae	Bidgee-widgee
Baeckea gunniana	Alpine Baeckea
Billardiera longiflora	Purple Appleberry
Bracteantha bracteata	Golden Everlasting
Cassinia longifolia	Shiny Cassinia
Coprosma hirtella	Rough Coprosma
Derwentia derwentiana	Derwent Speedwell
Epilobium gunnianum	Gunn's Willow-herb
Eucalyptus dalrympleana	Mountain Gum
E. obliqua	Messmate
E. radiata	Narrow-leaf Peppermint
Gaultheria appressa	Wax Berry
Geranium potentilloides	Cinque-foil Cranesbill
Leucopogon hookeri	Mountain Beard-heath
Linum marginale	Native Flax
Lomatia myricoides	River Lomatia
Nymphoides montana	Marshwort
Podolobium alpestre	Alpine Podolobium
Polyscias sambucifolia	Elderberry Panax
Ranunculus amphitrichus	Small River Buttercup
Rubus parvifolius	Small-leaf Bramble
**Stellaria media*	*Chickweed
Stylidium graminifolium	Grass Trigger-plant
Tasmannia xerophila	Alpine Pepper

Fig. 5. Flowering spike of Tall Spike-rush *Eleocharis sphacelata.*

Fig. 6. Purple appleberry *Billardiera longiflora.*

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Dear Editor,

This note refers to 'The Biogeography of *Pseudocephalozia paludicola* R.M. Schuster, an endemic Australian Liverwort' by Jon Sago (*The Victorian Naturalist* **115** (3), 1998, 84-86).

This liverwort has been found only twice in Victoria:

(1) At Mt Baw Baw above ski run 5; leg. and det. G.A.M Scott s.n. 25 June 1977, confirmed J. Engel 1981; MUCV 3217; and

(2) On the Alpine walking track NW of Mt Kernot; leg. and det. A.W. Thies 1452Q 26 January 1986; MEL 23301/ 242732 and MUCV 23301.

The latter location is within 5 km of the former. No collections are known from Mt St Gwinear and Mt Erica. The plant from Mt Torbreck was *Lepidozia laevifolia* as stated in the corrigendum on p. 82 of *The Victorian Naturalist* **116** (3). The location should be added to the first sentence of the corrigendum so that it reads 'The determination of the liverwort from Mt Torbreck referred to in "The Biogeography…" '.

Arthur W. Thies
National Herbarium, Royal Botanic Gardens, Birdwood Avenue, South Yarra, Victoria 3141.

Dear Editor,

Kibria's (1999) response to my letter which protested the inclusion of an article primarily on aquaculture (Romanowski 1999) in *The Victorian Naturalist* introduces new information which is dealt with from an aquaculture perspective only.

In particular, Kibria suggests I should have described an alternative to aquaculture as a way of rehabilitating Silver Perch populations, but this would have been inappropriate as the only mention of the entire subject in the original article is 'Such measures [to increase population] might include aquaculture'. However, as Kibria has introduced these new aspects, I will briefly show how far removed aquaculture is from conservation.

a) It is *not* 'widely accepted that overexploited and depleted fisheries can be rehabilitated through programs of artificial breeding, rearing and restocking in natural habitats' except in aquaculture circles, which is why only aquaculture references are cited in support of this sweeping generalisation. I don't know of any evidence of successful population enhancement of this kind for any fish, anywhere in the world. All improvements have been achieved by restoring habitat, and reducing fishing pressure (see also Horwitz 1995; Cadwallader and Lawrence 1995).

b) Electrophoretic methods of comparing variation between wild and hatchery populations of Rainbow Trout tell us little, but there is abundant evidence that hatchery and wild populations of trout are very different behaviourally and physiologically. Schweibert (1979) describes a comparison of a wild strain of Brook Trout with a hatchery stock originally from the same source, kept in identical adjacent pools on an identical diet for a year.

At the end of this time 'the domestic strain had reached more than five inches, while the wild fish were an inch and a half smaller ... the domestic fish were obviously attracted to the biologists, displaying no fear and expecting food, while the wild fish continued to flee'. Not surprisingly, after release into the same stream the wild fish showed higher survival and growth rates than the hatchery strains. These same phenomena can be observed in any aquaculture stock which has been captive bred for any length of time, because aquaculturalists select for individuals which breed most readily under artificial conditions, and which convert feed into flesh most efficiently.

c) Few captive breeding programs for fishes in Australia come close to using even the minimum FAO breeding group size of 50 Kibria cites. Thus, the Trout Cod restocking program he mentions uses eight fishes for breeding, while for Eastern Freshwater Cod the entire breeding group is 20 (Walker 1994). Even this figure is based on early theoretical work by Frankel and Soulé (1981), which is now universally regarded (including by Frankel and Soulé) as far below the minimum viable populations of hundreds, or perhaps even thousands, suggested by practical work on island biogeography (see for example Fiedler and Jain 1992).

The remainder of Kibria's response is largely irrelevant to the original article, or my letter – for example, discussion on 'improvement' of fish strains via triploidy. This has not been achieved with Silver Perch, but if it is, the production of faster-growing, sterile Silver Perch is certainly not going to be of any value in conservation!

Nick Romanowski
Dragonfly Aquatics,
RMB AB 366
via Colac, Victoria 3249.

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Dear Editor,

I refer to my earlier letter (Kibria 1999) in which I responded to a letter from Nick Romanowski regarding our review paper 'Biology and aquaculture of Silver Perch: A review' (Kibria *et al.* 1998).

In response to the latest letter from Romanowski, I am submitting the following:

(1) I am unsure what Romanowski means by 'aquaculture circles'. However, it is important to mention that fisheries and aquaculture scientists from all over the world work under one umbrella. Since these are interrelated disciplines (see also Kibria 1999), an integrated approach is required for sustainable fisheries and aquaculture development and management programs. Research findings generally complement each other (see the Annotated Bibliography for examples).

(2) Most of references cited in my letter (Kibria 1999) were from non-aquaculture related journals. Most importantly, the key conclusions were drawn from the findings of the world's recognised International Centre for Living Aquatic Resources Management (ICLARM), which is devoted to the management and conservation of biodiversity of aquatic organisms in Asia, Africa, Caribbean and Pacific islands.

(3) A recent paper shows that 'all research and production of Silver Perch to date used the progeny of wild broodfish and there has been no artificial selection' (Rowland 1997). Therefore the original claim, and its theoretical consequences mentioned by Romanowski (1999), is questionable.

(4) Some more examples of the success of stock enhancement programs are presented in the annotated bibliography (see also Kibria 1999).

Thank you once again. Sincerely yours,

Dr. Golam Kibria
Lincoln Marine Science Centre
Port Lincoln, South Australia 5606

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Editors note: The correspondence on this subject has now been closed.

Fungi Found in a Suburban Garden

Most naturalists are very aware of the interesting and intriguing things that can be found in their own gardens. There is always an assortment of invertebrates, lizards, frogs, birds and if you are lucky, mammals.

For many years I have prowled around my garden at night (regardless of weather conditions) with a torch or spotlight. A few hours spent gardening can also easily turn into double the time allowed because of interesting discoveries.

On 23 May (1999) I was unable to attend a fungi excursion led by Tom May (FNCV President) to Yarra Bend. To quell a little of the disappointment, I decided to search my own garden with a more thorough method than ever before and look for fungi.

I had previously recorded enough species to give me hope of some interesting finds. Fungi such as: *Gymnopilus pampeanus*, *Paxillus involutus*, *Schizophyllum commune*, *Lactarius torminosus*, *Amanita muscaria*, a slime mould *Stemonitis sp.*, and the ubiquitous *Agaricus xanthodermus*, the poisonous yellow-staining mushroom which seems to me to have become much more common in recent years (some common names of fungi are listed in Table 1).

Our block is the average quarter acre block, planted with exotic, native and some indigenous plants, the majority being native to Australia and indigenous to the Mitcham/Donvale areas.

The block is fairly steep which allows water to run off in winter, and is reasonably well drained. We are situated on the down side of a very steep hill where, in the sixties when we arrived here, a small creek once trickled past our house. The creek flowed into a tributary of the Mullum Mullum valley and on into the Mullum Mullum Creek and our block was surrounded by indigenous vegetation and lots of blackberry bushes

In my search, I set off with a hand lens, plastic container and a knife, heading for the area that had yielded the minute *Mycena viscidocruenta* in past years. Grasping a small stick lying on the soil I started to probe the leaf litter. I soon unearthed the first half dozen of these diminutive glistening red jewels, then something on the stick I was holding caught my eye. I could hardly believe my eyes or contain my excitement. I was looking down on a Bird's Nest Fungus, possibly *Cyathus olla*. This species has been listed as growing on soil, straw, twigs, fir cones, felled wood and planks in gardens. My specimen was growing on a small garden stake. The fungi did not have hairy cups as in *Nidula emodensis* and measured only 6 mm across the top of the goblet-like structure. The spore-bearing chambers (peridioles) were 1–2 mm. I found on further reading that this species prefers manured ground and is more frequently found in gardens than forests. My specimen was in a small vegetable garden!

As I worked my way assiduously around the garden in a clock-wise fashion I found the Smooth Ink Cap *Coprinus atramentarius*. Then as I crawled beside some railway sleepers I spied a tiny beige *Mycena* species peeping out from the cracks in the timber; next a patch of brown capped *Cortinarius* sp. growing among grass. Then a *Trametes* sp. – a polypore with pores instead of gills – growing on a dead stump, pure white, softly hairy on top at the back of the bracket, possibly *Trametes hirsuta*. Another velvet brown *Trametes* sp. with no distinctive zonation and a white under-surface remained a mystery. Finding the name adds to the interest of fungi study, but just understanding their important role in the environment and appreciating their wondrous colours and diversity of shapes is enough to keep my enthusiasm from ever diminishing.

By now a fine misty rain clothed the whole garden in a silver/grey curtain. I did wonder at the strange picture that I presented to the neighbours, looking down at me from the lofty heights of their windows over-looking our garden, as I crawled around in my wet weather gear on all fours!

Inspired by the discovery of the Birds Nest Fungus I very optimistically searched the fallen Banksia cones for the *Banksiamyces* sp. believed to grow on *Banksia spinulosa*, which is growing in my garden. With the aid of my hand lens I found four different types of fungi growing on a number of cones. One of the FUNGIMAP target species (the second for the

Table 1. Some of the fungi found in Cecily's garden at Mitcham

Scientific Name	Common Name
Agaricus xanthodermus	Yellow Stainer
Amanita muscaria	Fly Agaric
Coprinus atramentarius	Smooth (Common) Ink Cap
Coprinus micaceus	Glistening (Mica) Ink Cap
Cyathus olla	Bird's Nest Fungus
Gymnopilus pampaenus	
Lactarius torminosus	Woolly Milk Cap
Lepista nuda	Wood Blewit
Mycena viscidocruenta	
Nidula emodensis	Bird's Nest Fungus
Paxillus involutus	Brown Roll Rim
Schizophyllum commune	Split Gill
Stropharia aurantiaca	
Trametes hirsuta	Hairy Trametes

day, *Mycena viscidocruenta* being the first; see below for more details on FUNGIMAP) *Mycoacia subceracea* and a small white Ascomycete (Cup Fungus) with a stalk measuring 0.5 to 1 mm with hairy, deeply concave cups measuring 1.5 mm. As the cup matures it flattens out, possibly a *Lachnella* sp. The third species found on the cones was a small 2 mm white fungus with a 4–5 mm long translucent stalk (stipe). Under the lens it looked incredibly beautiful and fragile. The fourth species was a tiny pink gilled fungus with a cap 1.5 mm wide and a white stipe: a tiny gem with all the beauty of its larger counterparts that anyone with a land lens can enjoy.

The common red capped agaric *Stropharia aurantiaca* followed growing in some wood chips (mulched from cuttings from our own garden), while Glistening Ink Cap *Coprinus micaceus* was seen in grass near an old *Acacia elata* stump, looking like some exquisite art work from a child's fairy story book. On the stump, a mass of bracket fungi was growing in heavy brown solid tiers. This stump had been a source of fascination for some time as the mass had just continued to grow. During the dry autumn I had watered it, as an experiment to see just how big it would get. Unfortunately, I was unable to get spore prints from most of the Bracket species and its species name remains a mystery.

Another fascinating mystery is a small agaric with a plain white cap (diameter 5-6 mm) which will not yield a spore print. The gills have a pink tinge (maybe a clue) and the stem has a ring somewhat like a *Lepiota* without the freckles. This species also grows in indigenous bushland in the nearby Mullum Mullum valley.

Out in the front garden under the Silver Birch *Betula pendula* was a Wood Blewit *Lepista nuda* . This must surely be one of the more beautiful of fungi with its mauve gills and stem (see Bruce Fuhrer's lovely photo in *A Field Companion to Australian Fungi*). I have seen it many times before; another target species, I was delighted to find it in my own garden. *Hebeloma* sp., Fly Agaric *Amanita muscaria* and the Woolly Milk Cap *Lactarius torminosus* almost completed the collection.

I found several types of 'paint fungus' on sticks and small logs which were beyond my skills of identification. Some of them were white and some were fawn or brown.

Twenty-one species was the total that I found, many more possibly lay concealed under the ground or in places I missed altogether. I believe the total at Yarra Bend on the excursion I missed was 30. I was only 9 species down on that total and had not travelled out of my garden.

This was an interesting lesson to me to be more observant in the future, and brought to mind Tom May's suggestion recently that we could all note the fungi that we see while walking the dog, getting the paper or anywhere we take our recreation. I consider myself one of the lucky ones, I have the opportunity to walk in the nearby Mullum Mullum valley several times a week and have been recording the fungi for some time. I also walk in many bushland reserves on other days of the week. But I also believe that we can all contribute (if the interest is there). Look for some of the FUNGIMAP target species, many of which

are illustrated in Fuhrer (1985). This scheme records target fungi species from all parts of Australia (recent or old records are accepted) so that their distribution can be mapped. FUNGIMAP has produced a kit and beginners can start participating by using the coloured photos of the first target species for a guide. These are included in the instruction sheet. FUNGIMAP is a joint project by the FNCV, the National Herbarium of Victoria and the School of Ecology and Environment at Deakin University[1].

People who for whatever reason cannot travel far can also contribute to basic data on fungi. What a wonderful record we could build up of our garden fungi and what they grow on, without even leaving our own homes.

Now more than ever home owners both rural and suburban are planting indigenous, so our gardens have never before had such a variety of plants mixed with both native and exotic. This variety of flora reflects the variety of fauna visiting the home block. For example, whilst conducting this fungi survey I found native cockroaches, dozens of cicada nymphal skins, spiders of many varieties and a wonderful steel blue/grey 5-inch centipede. I am visited by many different bird species and even occassionally a Blue-tongue Lizard and Possums.

I found the survey yielded many more species than I could have imagined. It was heaps of fun and I would love to hear from others about their garden discoveries. Fungiphiles unite – your gardens await you.

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[1] If you would like to participate in this exciting new project, or for more information, contact FUNGIMAP, National Herbarium of Victoria, Birdwood Avenue, South Yarra, Victoria 3141, email fungimap@rbgmelb.org.au.

Further Reading

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Ant Behaviour

During a recent FNCV Botany Group excursion to the Brisbane Ranges, my attention was drawn to a well-worn trail made, and being used, by the 'Meat Ant' *Iridomyrmex purpureus*. In one place, this trail passed near a small depression in which ants of the genus *Camponotus* (commonly known as Sugar Ants) had built a nest. At the nest site, minor *Camponotus* worker ants were bringing soil out of the nest under the 'watchful eyes' of a number of majors. Occasionally an *I. purpureus* crossed this depression, whereupon all the *Camponotus* immediately retreated into the nest even though no contact was made between the two species. This behaviour was not related to size since the Meat Ants were smaller than both the minor and major *Camponotus* workers.

Iridomyrmex purpureus is a monomorphic species with worker castes all aproximately the same size – c. 8 mm. On the other hand *Camponotus* is a polymorphic genus with worker castes showing a large, continuous range in size from the small (minor) to large (major) workers (Shattuck 1999). The *Camponotus* sp. in my observation ranged in size from c. 10 mm (minors) to c. 15 mm (majors).

This behaviour of *Iridomyrmex* and *Camponotus* species has been reported by a number of authors – including Andersen

Table 1. P.J.M. Greenslade's Ecological Categories of Ants in Australia (Andersen 1987).

Category	Major taxa	Relevant features
1. Dominant species	*Iridomyrmex*	Highly abundant; active and aggressive; able to monopolise resources
2. Subordinate species	*Camponotus*	Large body size; polymorphic; submissive behaviour; nocturnal foraging
3. Climate specialists		
(a) Hot	*Melophorus* *Meranoplus*	Behavioural and morphological specialisations
(b) Cool	*Prolasius* *Notoncus*	Restricted to cool and wet regions where *Iridomyrmex* is at its climatic limit
4. Cryptic species	*Solenopsis* many *Ponerinae*	Activity confined to soil and litter
5. Opportunists	*Rhytidoponera* *Paratrechina*	Unspecialised; likely to interact strongly with *Iridomyrmex*
6. Generalised myrmicines	*Monomorium* *Pheidole* *Crematogaster*	Unspecialised species; recently arrived in evolutionary time
7. Large, solitary foragers	*Myrmecia*	Large body size; low population densities; unlikely to interact strongly with other ants

(1984, 1986a, 1986b, 1987, 1990, 1991 and 1992), and Greenslade (1976 and 1979). Table 1 shows seven ecological categories of ants, the most important of which consists of dominant species, chiefly *Iridomyrmex* (abundant, highly active and aggressive) which are often associated with subordinate species such as *Camponotus* (large size, mainly nocturnal and submissive towards *Iridomyrmex*). Table 1 is based on Greenslade's work and is taken from Andersen (1987).

Dominant ants have been described as 'both abundant and influential' (Greenslade 1976) and as 'highly active and aggressive ants that show rapid recruitment to food resources and an important competitive influence on the remainder of the ant community' (Andersen 1992).

Although my observation was made on a single occasion, for only a few minutes, and the ants were identified by sight alone, the observed behaviour of the *Camponotus* species does appear to agree with the 'submissive towards *Iridomyrmex*' behaviour described in the literature. Andersen (1992) also notes that *Camponotus* sp. often retreat when challenged (by *Iridomyrmex*).

However, this behaviour raises a question. What triggers the submissive behaviour of *Camponotus* towards *Iridomyrmex*? Is it recognition by sight, recognition by odour (pheromones) or is it an instinctive behaviour?

Can anyone help with answers?

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Mound-building Ants

I was interested to read 'Leafhoppers in Ant Nests', published in your February issue (Day and Pullen 1999), having lived adjacent to the mallee areas adjoining the Berri Irrigation areas until I left school.

My wife and I have visited the Calperum area on many occasions and the Cooltong paddock (west of Renmark) which is now the Conservation Park of the same name. About 15 of my visits over later years, with the South Australian Field Naturalists Society's Botany and Mammal Clubs, have been to Calperum and adjacent areas of the Bookmark Biosphere Reserve.

My wife pointed out that in Fig. 1 of Day and Pullen's article, above the first four letters of the word 'characteristic' in the caption, there is apparently a soil mound of *Camponotus clarior*.

This ant species usually nests under the base of mallee and where possible brings out the excavated soil via a hollow stem and drops it from the farthest projection which often results in an almost perfect cone.

I have been collecting ant specimens for Mr Archie McArthur, mentioned in the acknowledgements, since he spoke to a meeting of the Mammal Club on ant collecting. He pointed out that pitfall traps can serve a secondary purpose as a source of ant specimens.

The last paragraph you published poses 'If the eggs are inserted into the twigs or stems of the host plant, as in other eurymelids, how do the nymphs reach the nest of a host ant?'

I have discussed the matter with Archie and have suggested the ants collect the eggs of the leafhoppers and tend the eggs as their own. Apparently this is the case with the juvenile stages of the *Ogyris* butterfly, which feeds on mistletoe and is escorted by a species of ant related to the mound builders mentioned.

Cone-shaped mound of *Camponotus clarior*, Munyaroo Conservation Park, South Australia. Photo by G.L. Howie.

Some estimates are that there may be as many as 250 species of ants in mallee associations and I suspect there may be a number of examples of this behaviour with other ant species.

The photograph (above) of the ant mounds mentioned clearly shows the excavated soil as having been dropped from hollow stems of mallee.

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For assistance with the preparation of this issue, thanks to the computer team – Alistair Evans and Anne Morton. Thanks also to Felicity Garde (label printing) and Michael McBain (web page).

Australian Ants: Their Biology and Identification (Monographs on Invertebrate Taxonomy Volume 3)

by S. O. Shattuck

Publisher: *CSIRO Entomology, ISBN 0 643 06032 4.R.R.P. $89.95.*

Ants comprise an important group of organisms in most Australian terrestrial habitats. They are conspicuous and important in Australian ecosystems, especially in our arid regions. As such, they have become increasingly crucial to studies of the Australian environment, with many researchers, students, and natural historians with no prior history of entomology taking an interest in ant communities. Ants are now considered to be useful indicators of environmental disturbance, and are often included in habitat assessments along with plants and vertebrates.

This obviously creates a need for a comprehensive and user-friendly guide to the identification and biology of Australian ants, and in this book Steve Shattuck has produced just such a publication. Prior to this excellent book, researchers and students have relied on regional publications, such as Alan Andersen's *The Ants of Southern Australia; a guide to the Bassian fauna* and Peter Greenslade's *A Guide to Ants of South Australia*, both of which dealt admirably with the regions they covered, but were inappropriate for usage in the more northern and western parts of Australia, and did not include generic changes from recent taxonomic revisions. Additional guides to ant genera were to be found in global publications such as Barry Bolton's *Identification Guide to the Ant Genera of the World*, and within Hölldobler and Wilson's *The Ants*, but the keys in both of these publications are unwieldy and difficult to use for people without background knowledge of ant taxonomy and anatomy, with few illustrations in the case of Hölldobler and Wilson, and with only SEM (Scanning Electron Microscope) photographs in the case of Bolton.

Shattuck has rectified virtually all of these shortcomings in the literature by producing a clear and well-illustrated book of the Australian ant genera. The text of the book is set into an introductory section, a key, and a section which details each genus. There are also 30 colour plates illustrating aspects of ant biology and their interactions with the environment.

The introductory section briefly and succinctly summarises the general patterns of ant diversity in Australia, the biology and life-history of ants, ants as pests, the use of ants in environmental monitoring, the classification of ants, use of keys for identification, anatomical terms, ant collection techniques, specimen preparation and curation, and suggested reading for those wishing to look further into aspects of ant biology and taxonomy. These sections have been kept to an admirable minimum - commendable given the vast quantity of published information.

The key is the heart of this book, and the author has spent much time developing and fine-tuning the key by allowing active ant researchers to use drafts during the key's development. Every couplet is illustrated, often with more than one character. The illustrations, produced by Natalie Barnett, are uncluttered, and the characters are indicated by arrows, or shading so that there is no ambiguity. Given an adequate stereo dissecting microscope, and a good light source, this key should allow confident identifications of most ants to the generic level, even for the inexperienced ant enthusiast. The layout of the key is fairly standard for ant identification; specimens are first keyed out to subfamily then, in a separate key, to genus.

The final section of the book deals with each subfamily and genus. There are 103 ant genera currently known from Australia, so this section comprises a large part of the publication. For each subfamily there is a section detailing identification, and an overview of the subfamily in Australia. For each genus there are sections detailing identification, biology, distribution and habitats, and a list of names of the currently described Australian species. There are

also two or more SEM photographs for each genus, usually of a frontal view of the head and a lateral view of the alitrunk, and a distribution map which shows collection sites. The identification section is an important part of the generic descriptions, as it allows the key user to confirm their placement of a specimen. Similar genera are compared, and the characters used to separate them described, so that the reader can further clarify their identifications. The descriptions of biology are fascinating, and the reader will soon realise just how much work remains to be done on the natural history of Australia's ants. The scope of research areas available is also emphasised by the inclusion of three undescribed genera within the book; no doubt this book will encourage field workers to locate even more! The associated distribution and habitat information tells us the general distribution of ant genera both within and outside Australia. This gives the reader an idea of the endemicity of many Australian genera.

I could find no errors in this publication, and if I had any complaints at all, it might be that it would have been good to put some basic taxonomic history in the generic descriptions. This would enable the reader to compare previously published names in the literature where there have been taxonomic changes in recent times. For example, *Iridomyrmex*, a diverse and ecologically significant ant genus, formerly included the ant genera *Papyrius*, *Ochetellus*, *Anonychomyrma*, *Doleromyrma*, *Linepithema*, and *Philidris* within its scope until recently revised by Shattuck.

Shattuck has put together a book which will become the standard text for researchers, enthusiasts and students who wish to understand Australian ant diversity. It will find use in areas well removed from general entomology, such as in environmental management and botany, and is a fine inclusion in CSIRO's Monographs on Invertebrate Taxonomy series.

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Beauty in Truth: the Botanical Art of Margaret Stones

by Irena Zdanowicz

Publisher: *National Gallery of Victoria, 1996. 96 pp., 108 colour plates.*

Brilliant Careers: Women Collectors and Illustrators in Queensland

by Judith McKay

Publisher: *Queensland Museum, 1997. 80 pp., numerous illustrations (black & white and colour). RRP $19.95.*

Exhibitions are limited in time and space. But their associated publications endure and some deserve a continuing readership. I think that these two books certainly do.

Dr Margaret Stones is a remarkable and renowned botanical artist. She began her botanical work in Victoria in the 1940s, and has lived for most of her life near the Royal Botanic Gardens at Kew, England, from where she has travelled back and forth across the world to draw plants in their native habitats. In *Beauty in Truth* Irena Zdanowicz provides an insightful biography of Margaret Stones and a description of her working methods. Rarely does an exhibition catalogue include illustrations of all work exhibited, but Irena Zdanowicz convinced the

Gallery that this should be done for the mavellous retrospective exhibition held in 1996, which spanned fifty years of Margaret Stones' work. Irena Zdanowicz also insisted on high quality illustrations in the catalogue. While no reproduction can ever match the incredible light and life – the beauty and truth – in Margaret Stones' original work, the illustrations in *Beauty in Truth* are stunning – all 108 plates. They include work carried out during two major projects: on the endemic flora of Tasmania (in conjunction with the botanist Dr Winifred Curtis) and on the flora of Louisiana (USA). Botanical notes for each plate were prepared by Professor Carrick Chambers, and Drs. Don Foreman, Linden Gillbank, David Hunt and Lowell Urbatsch. The index includes taxonomic and common plant names.

Dr Judith McKay prepared *Brilliant Careers* to accompany the Queensland Museum's 1997 exhibition in its series of annual exhibitions for International Women's Day. *Brilliant Careers* `pays tribute to a remarkable group of women who, as scientific collectors and illustrators over the past 150 years, have extended our knowledge of the Queensland environment and people. All have left a public legacy in their contributions to museums and herbarium collections, or in their publications and advocacy of conservation causes.'

The work of 34 women is discussed by various authors. Maida Allan, Elizabeth Coxen, Harriette Biddulph, Ada McLaughlin and Mabel Hobler collected specimens in the vicinity of their Queensland pastoral homes. In the 1860s Amalie Dietrich was employed to collect natural history specimens for a German museum. After retiring from teaching in 1895 Selina Lovell collected plant specimens in Cooktown, where in the 1970s Vera Scarth-Johnson, inspired by the beauty of the Endeavour River and the early work of Joseph Banks and Daniel Solander, began collecting and painting the local flora. An earlier artistic visitor was Ellis Rowan, about whom Judith McKay wrote *Ellis Rowan – A Flower-Hunter in Queensland*, which was published in 1990 by the Queensland Museum in concert with an exhibition of its collection of 125 Queensland flower paintings by Ellis Rowan. Dr Dorothy Hill taught geology and paleontology at the University of Queensland from 1946–72 and became the first female Fellow of the Australian Academy of Science. Many of the women discussed in *Brilliant Careers*, including Joan Cribb, Doris Goy, Hilda Geissmann, Mabel Hobler and Estelle Thomson, were members of the Queensland Naturalists' Club.

It is too late to visit these two exhibitions, but it is not too late to enjoy these beautiful books. Unfortunately *Beauty in Truth* is out of print, but *Brilliant Careers* is still available at the Queensland Museum, and I would hope elsewhere. They should both be in any library which claims to have a good Australiana or Australian natural history collection.

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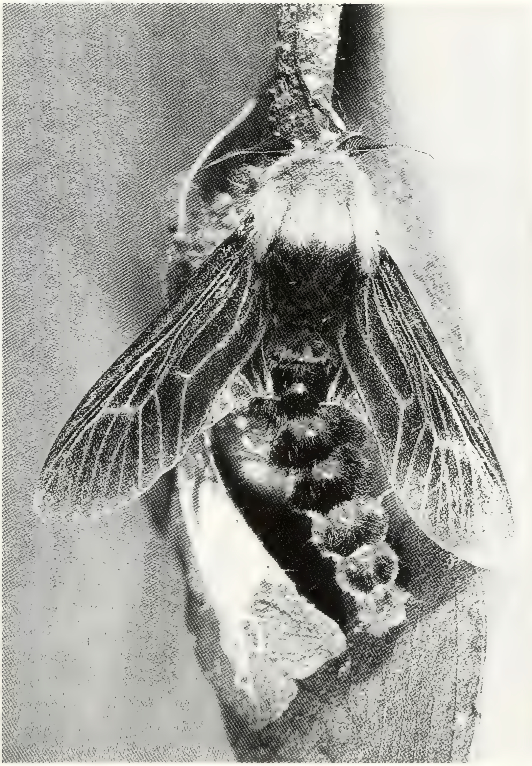

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FNCV Honorary Life Member Jack Hyett

Jack Hyett worked for the Education Department of Victoria from 1933 until 1976, first as a primary school teacher, and after 1963 as a professional officer, Teachers' College at Burwood. Later he worked as a Science lecturer at Burwood State College. He lectured for the Council of Adult Education on *Bird Study in Australia*, directed their Outback Study Schools, and led birdwatching and wildlife tours in Australia and overseas. He toured places such as the Galapagos Islands, Ecuador, Sri Lanka, India and South Africa. Jack can tell stories of some interesting events that occurred on some of those tours, especially the African ones.

In 1933 he joined the Bird Observers' Club of Australia, and was the custodian of their historic photographic collection for several years. He was the foundation president of the Ringwood Field Naturalist Club and the Victorian Ornithological Research Group, and is a member of several natural history clubs including the FNCV, RAOU (now Birds Australia) and the Wildlife Preservation Society of Sri Lanka.

He served for seven years on the bird survey of Wilson's Promontory, and also conducted the mammal survey of the Promontory.

Jack Hyett has published several books and numerous articles on birds and mammals, edited four volumes of *The Emu*, and has sub-edited *The Australian Birdwatcher*, for which he has prepared indices, as well as a bird species index to the first 100 volumes of *The Victorian Naturalist*. Jack was the Australian Natural History Medallionist in November 1985.

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Jack Hyett (right), receives his honorary certificate of FNCV Life Membership from Vice President Noel Schleiger at Covenant House, Canterbury Road, Blackburn on Friday, 28 May, 1999.

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Cover: Adult male Saunders Casemoth *Oiketicus elongatus*. See story on p. 175. Photograph by Arthur Farnworth.

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Australian Natural History Medal 1999

Mary Patricia Cameron

The Queen Victoria Museum and Art Gallery in Launceston has a botanical collection of such high standard that its Herbarium is now recognised as a major centre of botanical research in Tasmania. Mary Cameron, in her voluntary capacity as Research Associate, curates the collection and provides a plant identification service for the public as well as private companies. The Herbarium contains some 20,000 plants together with a collection of Tasmanian timbers. The City Council honoured Mary in recognition of 5,000 hours of work for the Launceston Community.

In 1947 Mary Cameron graduated as Bachelor of Science from the University of Tasmania with a major in botany, and she taught science subjects in Tasmanian secondary schools for several years. She also gave long service as part time reference librarian at the Northern Regional library, Launceston, until her retirement. Mary maintained her botanical studies and pursuits wherever possible while raising a family of six children and fulfilling the demands of employment. As spare time became available she devoted an ever increasing amount of time and energy to botany. In about 1969 she became Honorary Curator of the Herbarium at the Queen Victoria Museum and set about reorganising and improving the presentation of the collection in addition to the formal tasks of collecting, identifying and preserving specimens. In 1972 she was appointed Honorary Botanist and in 1987 the City of Launceston recognised her 'enormous contribution ... to the Museum's botanical collection and to the community through the provision of information' by elevating her to the position of Honorary Research Associate of the Queen Victoria Museum and Art Gallery.

Mary Cameron's botanical investigations and vegetation surveys date from the 1960s and have been the basis for a number of publications. She collected plants and provided distribution information for Lord Talbot de Malahide who published the six volume work 'The Endemic Flora of Tasmania' during the period 1967-1978, and she edited and wrote much of the text of the Launceston Field Naturalists Club's publication 'Guide to the Flowers and Plants of Tasmania' and its three revisions. With the support of the Plomley Foundation and the Museum she has been studying the flora of many different types of wetlands in north east Tasmania, resulting in a number of joint publications on flora lists and ecological details. With the assistance of the Museum's photographer, Mark Bartkevicius, Mary has amassed a large slide collection of Tasmanian orchids to record details of soft tissues which are lost in preservation. The collection and distribution records have been used in the writing of volumes of the 'Flora of Australia' and a forthcoming 'Atlas of Tasmanian Orchids'.

The Royal Society of Tasmania and the Launceston Field Naturalists Club have benefited from Mary's contributions over many years. She joined the Royal Society in 1946, became a life member in the 1950s and was a member of its Council on several occasions. Also she was vice chairman and Chairman of its Northern Branch, contributing to the planning and conduct of the Branch's program of lectures and excursions. The Field Naturalists Club made her an honorary life member recognising her long service as committee member, librarian, vice president and president. She has given numerous talks to the Club, arranged and led botanical excursions, and written detailed reports for its publications.

In 1993 Mary Cameron was made a Member of the Order of Australia for 'outstanding service to the study of the botany of Tasmania, and botanical and environmental conservation'. She has a long history of service on a number of conservation committees and advisory groups. The Tasmanian Conservation Trust, the Australian Heritage Commission Evaluation Panel (Tasmanian Section), the Department of National Parks and Wildlife's Flora Advisory Committee and its Rare and Threatened Species

Committee are among the bodies on which she has served. She is a member of the Tasmanian Arboretum Inc. which, in an endeavour to prevent the loss of woody plant species through forest destruction, has established collections of flora from various parts of the world on a 45 hectare property at Eugenana. At a local level, Mary has directed the planting of Australian sub-alpine flora on a 60 hectare property of the Launceston Field Naturalists Club and a collection of endemic flora at a site near Scottsdale as a Bicentennial project.

The Launceston Field Naturalists Club had great pleasure in nominating Mary Cameron for the award of the Australian Natural History Medallion.

Ian Endersby
56 Looker Road,
Montmorency, Victoria 3094.

Editor's note: The Australian Natural History Medallion will be presented to Mary Cameron at a meeting of the FNCV on Monday, 8 November 1999 at 8:00 pm. The presentation will take place at the FNCV Hall, 1 Gardenia Street, Blackburn, Victoria. After the presentation, Mary Cameron will speak on 'Conservation of Tasmanian Plants'. All welcome.

Mary Cameron, awarded the Australian Natural History Medal for 1999. Photo by John Simmons, Tasmania.

Fire Effects on Selected Terrestrial Invertebrate Fauna in Heathland at Wilsons Promontory, Victoria – a Preliminary Survey

E.J. Grey[1]

Abstract
A preliminary study of ants, beetles and spiders was conducted at two heathland sites in Wilsons Promontory National Park – one most recently burnt in 1991, the other in 1998. There was sufficient difference in the ant fauna, particularly in the abundance of *Rhytidoponera* species, to indicate that a more comprehensive study is warranted. (*The Victorian Naturalist* **116** (5), 1999, 162-168.)

Introduction

The Field Naturalists Club of Victoria Inc. conducted a research trip to Wilsons Promontory in October 1998. The work undertaken included this invertebrate survey, as well as the identification of grasses and sedges by workshop and field study, mammal surveying by trapping and spotlighting and freshwater invertebrate sampling.

The invertebrate survey aimed to provide baseline data on ant (Hymenoptera), beetle (Coleoptera) and spider (Araneae) fauna in two heathland sites – one unburnt since 1991 and referred to in the text as the ***unburnt*** site, and the other burnt in 1998 and referred to as the ***burnt*** site. An evaluation of the differences in species abundance and diversity between the two habitats was also made. The study was set up so that further work could continue in order to monitor the changes in invertebrate fauna as the recently burnt heath regenerated, using the site last burnt in 1991 as a control.

Earlier work on ant diversity, seasonality and community organisation had been conducted by Andersen (1986) in heath and woodland sites near Tidal River, toward the southern end of the Park. Andersen's study found that total ant activity was temperature and weather dependent, and also that opportunistic species, such as *Rhytidoponera*, predominated.

Study site

In May 1998, Parks Victoria burnt some of the heathland in an area along Five Mile Track overlooking Corner Inlet at the northern end of the Park. The two study sites were located on an exposed saddle at 38°54'52" S, 146°21'06" E, with an elevation of 140 m above-sea-level. Both sites had a slight westerly slope but were on opposite sides of the track c. 100 m apart, and both had similar soils, derived from granite, with high clay content and medium to coarse quartz grains. Due to the clay content, the soil has low water permeability.

The heath site on the north side of the track, although not burnt in 1998, has had an extensive fire history, having been burnt in 1951, 1957, 1973, May 1988 and October 1991. In contrast, the heath site burnt in May 1998 (a prescribed burn), which lies on the south side of the track, had only been burned in 1951 and 1957 (Jim Whelan *pers. comm.*).

Vegetation on the unburnt heath site was dominated by Prickly Tea-tree *Leptospermum continentale*, Dwarf Sheoke *Allocasuarina paradoxa* and White Kunzea *Kunzea ambigua*. Other plants included Butterfly Flag *Diplarrena moraea*, Australian Dusty Miller *Spyridium parvifolium*, Pink Heath *Epacris impressa*, Silver Banksia *Banksia marginata*, Dagger Hakea *Hakea teretifolia* subsp. *hirsuta*, Furze Hakea *H. ulicina*, and Silky Hakea *H. sericea*. Vegetation height was approximately 1.0–1.5 m (Fig. 1).

There was little vegetation on the burnt heath site except for isolated clumps of Butterfly Flag and a scattering of emerging seedlings which were not identified (Fig. 2). However, prior to the May 1998 burn, the vegetation was higher and denser than at the unburnt site with *Allocasuarina paradoxa* being the most abundant species (Jim Whelan *pers. comm.*).

Methods

At each site, five lines of five pitfall traps were put in (25 traps at each site) to form a

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Fig. 1. The unburnt heath site. Installing pit-fall traps – Elsbeth Sacco, Pat Grey and Erich Sacco.

square grid. Each line was separated by five metres, with five metres spacing between traps. For the traps, plastic coffee cups were used with 200 ml capacity, height 80 mm and a top diameter of 72 mm. Each trap was dug in, so that the top was flush with the ground, and 30 ml of preserving fluid put in each trap. The preserving liquid consisted of a 50/50 mixture of ethylene glycol and ethanol (70%). The traps were open for a seven-day period from 3–10 October 1998.

The weather, while the pitfall traps were open, was cool and windy with some rain. Rainfall and min/max temperatures were measured on site – 29 mm of rain was recorded, and a temperature range of 7-16°C.

Hand collecting for ants and beetles and spiders was carried out within the boundaries of each site for 30 minutes by ten people on 10 October 1998, when the weather was mild and sunny. Material was collected from foliage, under litter and on the ground. In order to equalise the collecting effort, the same ten people were involved at each site.

Identification of ants was taken to species level, where possible, or they were assigned to a species group (indicated throughout this report by inverted commas). Andersen (1990) defines a 'species group' by saying that 'even though most species cannot be confidently named, many can be readily assigned to groups with distinct morphologies, habits and distributions'. As an example, *Anonychomyrma* (was *Iridomyrmex*) '*itinerans*' refers to a complex of species closely allied to, and including, *A. itinerans*. However, some ants could only be identified to genus. Beetles and spiders were identified to family level. All other material captured was retained as 'miscellaneous'.

The keys used for identification were taken from a variety of sources : ants – Andersen 1991, Greenslade 1979 and one derived from New *et al.* 1996; beetles – Moore 1980; and spiders – Davies 1986.

Results

Pitfall trapping

Total numbers of ants, beetles and spiders recorded from pitfall traps are shown in Table 1. Ants were by far the most numerous group in both sites, while beetles and spiders comprised only 17% and 9.5% respectively in the unburnt site, and 4.2% and 6% respectively at the burnt site.

Fig. 2. The burnt heath site.

Table 1. Total numbers of ants, beetles and spiders collected in pitfall traps.

	Ants (Hymenoptera)	Beetles (Coleoptera)	Spiders (Araneae)
Unburnt Heath	219	54	38
Burnt Heath	210	10	14

Ants (Hymenoptera:Formicidae)

The ants, when identified to sub-family level, showed considerable differences in numbers between the two sites (Table 2). In the unburnt heath, the sub-family Ponerinae far outnumbered the Ponerinae found in the burnt heath (175 v 47), while the sub-families Myrmicinae, Dolichoderinae and Formicinae in the unburnt heath were greatly outnumbered by those at the burnt site. However, the total numbers of individual animals at both sites were fairly equal (219 in the unburnt site and 210 in the burnt site).

In contrast, ant diversity was decidedly higher in the burnt heath with 24 taxa (species, species groups or genera) compared with 14 in the unburnt heath (Table 2).

In the unburnt heath site, the two most abundant species were *Rhytidoponera tasmaniensis* and *R. victoriae* (153 and 21 respectively), which together accounted for 79% of all ants collected. Species of Dolichoderinae and Formicinae made up most of the balance. *Rhytidoponera tasmaniensis* and *R. victoriae* were also recorded in the burnt heath, but in much lower numbers, 80% less than in the unburnt heath, and members of the subfamilies Dolichoderinae, Myrmicinae and Formicinae were more equally represented.

The greatest variety of taxa for both sites was found in the sub-families Myrmicinae (unburnt 4, burnt 8) and Formicinae (unburnt 4, burnt 10). *Monomorium kiliani* was the most numerous of the Myrmicinae in the unburnt heath, while *Crematogaster* sp., *Meranoplus* sp. and *Pheidole* sp. were the most numerous in the burnt heath. In the Formicinae, the most numerous were *Pseudonotoncus* sp. (unburnt site, 11), and *Paratrechina* '*minutula*' (burnt site, 22).

Beetles (Coleoptera)

In contrast to ants, the unburnt heath had the greatest number of individuals captured in pitfall traps (Table 3) and the greatest beetle richness at family level – eight fami-

Table 2. Total ants (Hymenoptera: Formicidae) in Pitfall Traps. + This species was only collected by hand and did not appear in the pitfall traps.

Sub-family	Species	Unburnt Heath	Burnt Heath
Myrmeciinae	*Myrmecia forficata*	0	1
	Myrmecia nigriscapa	1	0
	Myrmecia 'pilosula'		+
	Total	**1**	**1**
Myrmicinae	*Aphaenogaster longiceps*	0	1
	Crematogaster sp.	1	14
	Meranoplus sp.	1	17
	Monomorium kiliani	3	1
	Monomorium sp.	1	3
	Orectognathus clarki	0	1
	Pheidole sp.	0	17
	Solenopsis sp.	0	2
	Total	**6**	**56**
Ponerinae	*Amblyopone australis*	1	
	Rhytidoponera tasmaniensis	153	43
	Rhytidoponera victoriae	21	3
	Total	**175**	**47**
Dolichoderinae	*Iridomyrmex 'bicknelli'*	0	1
	Anonychomyrma 'itinerans'	13	3
	Anonychomyrma 'nitidiceps'	6	65
	Tapinoma minutum	+	
	Total	**19**	**69**
Formicinae	*Camponotus 'claripes'*	3	2
	Camponotus sp.	0	1
	Camponotus 'nigroaeneus'	+	+
	Notoncus ectatommoides	3	0
	Notoncus hickmani	0	4
	Paratrechina 'minutula'	0	22
	Paratrechina sp.	0	2
	Plagiolepis sp.	1	1
	Polyrachis patiens	0	3
	Prolasius sp. nr. *bruneus*	0	1
	Prolasius sp.	0	1
	Pseudonotoncus sp.	11	0
	*Stigmacros (Hagiostigmacros)*sp.	0	1
	Total	**18**	**37**
Total number of individuals recorded		**219**	**210**
Total number of taxa in pitfall traps		**14**	**24**

Table 3. Total beetles (Coleoptera) in pitfall traps. + This family was only collected by hand and did not appear in the pitfall traps.

Family	Unburnt Heath	Burnt Heath
Buprestidae (Jewel Beetles)	+	
Carabidae (Ground Beetles)	1	0
Curculionidae (Weevils)	2	2
Chrysomelidae (Leaf Beetles)	+	
Elateridae (Click Beetles)	1	0
Pselaphidae	2	0
Ptinidae (Spider Beetles)	1	0
Staphylinidae (Rove Beetles)	42	7
Tenebrionidae (Darkling Beetles)	0	1
Trogidae	4	0
Undetermined	1	0
Total number of individuals	**54**	**10**
Total number of families in pitfall traps	**8**	**3**

Table 4. Total spiders (Araneae) in pitfall traps. + This family was only collected by hand and did not appear in the pitfall traps. Imm = immature; damed = damaged.

Family	Unburnt Heath Male	Unburnt Heath Female	Burnt Heath Male	Burnt Heath Female
Amaurobiidae	1	0	0	0
Clubionidae	5 (2 imm)	1	3	O
Dictynidae	0	0	1	0
Gnaphosidae	2	1 (1 imm)	0	0
Hadrotarsinae	0	0	+	0
Lycosidae	19	6	4	1
Miturgidae	1 (1 imm)	0	1	0
Salticidae	0	+	+	0
Theridiidae	1	0	0	0
Thomisidae	0	0	1	0
Undetermined	1	0	3 (2 damed)	0
Total number of individuals	**30**	**8**	**13**	**1**
Total number from each site	**38**		**14**	
Total number of families	**6**		**3**	

lies were identified in the unburnt site compared with three in the burnt site. Rove Beetles (Staphylinidae) were the most abundant family at both sites, and apart from Tenebrionidae, the families found in the burnt heath were also found in the unburnt site.

Spiders (Araneae)

Male spiders (83% of the total) far outnumbered females. This is not unexpected since it is the habit of male spiders to wander around in search of mates.

Active, hunting spiders from the families Clubionidae, Gnaphosidae, Lycosidae (Wolf Spiders) and Miturgidae were the most abundant of the spider fauna captured in pitflall traps – 92% of the total in the unburnt heath and 69% of the total in the burnt heath.

One individual was trapped from each of the following families – Amaurobiidae (unburnt site) and Dictynidae (burnt site). These spiders build lacy webs, similar to those built by the commonly seen Black House Spider.

The single Theridiidae found in the unburnt site elongs to the same family as the Redback Spider and builds a gum-footed snare.

One Flower Spider (Thomisidae) was found in the burnt site.

Hand Collecting

The results of hand collecting are shown in Tables 5 and 6.

Table 5 shows the total number of individuals collected in each order. Again, over 90% were ants.

Table 5. Total numbers of ants, beetles and spiders collected by hand.

	Ants Hymenoptera	Beetles Coleoptera	Spiders Araneae
Unburnt Heath	86	5	4
Burnt Heath	56	3	2

Table 6 shows the breakdown of the ants into subfamilies and species. Numerically, 60.5% were caught at the unburnt site. In the unburnt heath the most abundant family was the Dolichoderinae (55% of total) with *Anonychomyrma 'nitidiceps'* being the most abundant species (36 individuals). The latter was also abundant at the burnt site (17), but *Meranoplus* sp. from the subfamily Myrmicinae (13) and *Camponotus 'nigroaeneus'* from the sub-family Formicinae (12) were a fairly close second.

The numbers of beetles and spiders collected by hand were small and no further analysis was done.

Discussion

It was unfortunate that no pre-fire data are available on the fauna present at the sites, and this study started five months after the 1998 burn. Another factor that must be taken into account is the difference in vegetation between the two sites prior to the 1998 burn which may have contributed to the differences in fauna found in this survey. Additionally, the burnt heath site had a long, 40 year period

Table 6. Ants (Hymenoptera) collected by hand.

Family	Species	Unburnt Heath	Burnt Heath
Myrmeciinae	*Myrmecia forficata*	0	2
	Myrmecia nigriscapa	1	0
	Myrmecia 'pilosula'	0	2
	Total	**1**	**4**
Myrmicinae	*Aphaenogaster longiceps*	0	3
	Meranoplus sp.	9	13
	Monomorium 'kiliani'	7	0
	Total	**16**	**16**
Ponerinae	*Rhytidoponera tasmaniensis*	20	4
	Rhytidoponera victoriae	0	3
	Total	**20**	**7**
Dolichoderinae	*Iridomyrmex 'bicknelli'*	5	0
	Anonychomyrma 'itinerans'	4	0
	Anonychomyrma 'nitidiceps'	36	17
	Tapinoma minutum	2	0
	Total	**47**	**17**
Formicinae	*Camponotus 'nigroaeneus'*	2	12
	Total	**2**	**12**
Total number of individuals		**86**	**56**
Total number of species		**9**	**8**

without burning and this may be a further factor in the faunal differences found. Also the cool, damp weather experienced during the trapping period may well have inhibited total ant foraging activity and influenced the number recorded. However,the results obtained from the survey show sufficient variation in the species composition of the ant fauna at each site to enable comparison with future work.

For the unburnt heath ant fauna, the outstanding feature was the abundance of the opportunistic, omnivorous *Rhytidoponera* species in contrast to the low numbers of highly active, aggressive *Anonychomyrma* species. In part this may be due to the cool weather, since *Anonychomyrma* sp. are more active in sunny areas (Andersen 1991), but a paucity of *Anonychomyrma* also occurs with less insolation (solar radiation) at ground level, for example in dense heath vegetation (Andersen 1986).

In the burnt heath site, a number of factors may have affected the results: open ground, as in the bare, burnt heath site favours pitfall trapping and thus, the results might be an artefact of the method used, as well as site differences; open habitats favour the ant species *Anonychomyrma* (33% of the total), where their aggressive behaviour and numbers suppress the subordinate *Rhytidoponera* species (Andersen *pers. comm.* November 1998), hence the difference in *Rhytidoponera* numbers between the two sites (79% and 22% of the total). However, a number of generalised Myrmicines such as *Crematogaster, Meranoplus, Monomorium* and *Pheidole* species (25% of total) which are seed harvesters/ honeydew feeders and have flexible foraging times, i.e. can forage both during the day and night, appear able to coexist with *Anonychomyrma* at this site. The nocturnal, litter-foraging *Paratrechina minutula* (11%) would not be a competitor. An interesting aspect is the virtual absence of *Aphaenogaster* at both sites compared with the numbers found in heath near Tidal River by Andersen (1986). It is possible that the high clay content of the soil may be an influence as this species is more abundant in sandy soils (Andersen 1991). The greater amount of insolation received on the bare ground surface of the burnt heath may have induced greater ant activity.

The beetle fauna was relatively similar at both sites. The greater numbers recorded in the unburnt heath might be associated with shelter and availability of food. The abundance of the predacious Rove Beetles is a point of interest, since these beetles tend to prefer wetter areas because their short elytra (wing covers) and slender form does not allow them to resist dry conditions

(Moore 1980). The cool, damp weather experienced during the trapping would have suited them.

Given the limitations of this study - the fire history of both sites, vegetation differences before the 1998 burn, no pre-fire data - the results still provide a useful starting point for documenting changes in the faunal composition as the burnt heath regenerates.

Acknowledgements

The field work was conducted under Parks Victoria Permit 10000179 and, made possible with help from Parks Victoria Rangers, members of the invertebrate survey team from the FNCV and other field naturalists. Special mention should be made of the contribution made by Erich and Elsbeth Sacco for help in setting up the trapping lines, and to members of the survey team for identification work. Alan Andersen (CSIRO) also made valuable comments on the differences in behaviour of the ant fauna. Jim Whelan (Ranger-in-Charge) provided valuable information on fire histories. Alan Yen (MOV) made suggestions which improved an early draft.

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Corroboree Frog *Pseudophryne corroboree*

My late husband and I were at Mt Kosciusko in the summer of 1968. Naturally, we enquired where we could find **the** frog and were directed to a suitable location.

Here in the very wet sphagnum beds we found frogs galore, along with their eggs. The eggs were larger than those of lowland frogs. Every puddle was full of tadpoles. The frogs were curious things; they didn't hop but crawled persistently out of focus, proving difficult to photograph as they were constantly crawling away.

J. Barker and G. Grigg (1977), in '*A Field Guide to Australian Frogs*', have this to say: 'Found in sphagnum bogs above 1500 m. Ten or twelve large eggs. Short breeding season, December to February. Tadpoles similar to other *Pseudophryne*.'

I wonder how the dry years are affecting them. Certainly 'ordinary' frogs seem to have gotten scarcer.

Corroboree Frog *Pseudophryne corroboree* with eggs. Photo by D.W. Lyndon.

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New Holland Mouse *Pseudomys novaehollandiae* (Rodentia: Muridae): Further Findings at Yanakie Isthmus, Wilsons Promontory National Park

Bruce W. Atkin[1] and Bruce R. Quin[2]

Abstract

Trapping for the New Holland Mouse *Pseudomys novaehollandiae* was carried out on the Yanakie Isthmus area of Wilsons Promontory National Park, southern Victoria, in May 1996 as part of a program aimed at determining appropriate habitat management for this species. During previous surveys in the vicinity, the New Holland Mouse had been captured only on vegetated dunes. However, on this occasion a number were trapped in open swales. This finding may increase our understanding of the habitat requirements of the New Holland Mouse. The shrub layer in the swales, dominated by Coast Tea-tree *Leptospermum laevigatum,* had been slashed within the previous three years; it is possible that the regrowth had reached a stage of succession where it was providing sufficient cover for New Holland Mice, perhaps coupled with an increased abundance of food. This paper describes the results of the trapping program and provides recommendations for future management of the New Holland Mouse and its habitat at Yanakie Isthmus, Wilsons Promontory National Park. (*The Victorian Naturalist* **116** (5), 1999, 169-172.)

Introduction

The New Holland Mouse was first recorded on the Yanakie Isthmus area of Wilsons Promontory National Park during 1993. It was found on dunes vegetated with mature *Banksia* and *Allocasuarina* woodland, with an understorey dominated by sedges and low shrubs (Quin 1996; Quin and Williamson 1996). It had previously been recorded on the Promontory near Darby Swamp and Five-Mile Road (Fig. 1) in the early to mid-1970s (Seebeck *et al.* 1996).

In an attempt to determine appropriate management of dune and swale vegetation for the New Holland Mouse, a trial exclusion plot of 25 m × 25 m was proposed, to prevent grazing by herbivores (Chesterfield *et al.* 1995). The purpose of the plot was to assist managers in determining whether or not the elimination of grazing would lead to restoration of a Kangaroo Grass *Themeda triandra* native grassland/ open woodland, thus conserving habitat of the New Holland Mouse (Quin and Williamson 1996).

The aim of this study was to determine the presence and distribution of the New Holland Mouse in the vicinity of the proposed exclusion plot. Future trapping would then reveal whether the New Holland Mouse utilised the restored grassland as habitat.

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Study Area, Materials and Methods

The study site was immediately west of the main access road to Tidal River, about three kilometres south of the entrance to the Park and 10 km north of Darby River (Fig. 1).

The dunes in the area are generally three to five metres in height and vegetated as described in the introduction. The vegetation in the swales, which are generally up to 50 m wide, has been described as rough grassland (Chesterfield *et al.* 1995). Grazing pressure from Eastern Grey Kangaroos *Macropus giganteus*, Common Wombats *Vombatus ursinus* and European Rabbits *Oryctolagus cuniculus* is heavy and bare ground is common, ranging from <5% to 40% (B.W. Atkin, p*ers. obs.*). The vegetation is dominated by a few apparently unpalatable species, particularly Black-anther Flax-lily *Dianella revoluta*, Silky Guinea-flower *Hibbertia sericea* and Coast Tea-tree *Leptospermum laevigatum.*

The swales in the study area were slashed initially in March 1992 and again in December 1993, to control the spread of Coast Tea-tree (P. McDiarmid, Ranger, Parks Victoria, Yanakie *pers. comm.*). Coast Tea-tree invasion of dune vegetation is believed to threaten populations of the New Holland Mouse because the resulting Tea-tree thicket out-competes the vegetation community it occupies. The New Holland Mouse has not been located in well established Tea-tree monocultures (Quin and Williamson 1996). At the time

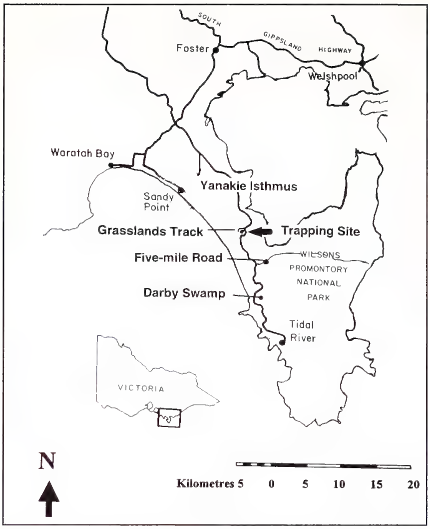

Fig. 1. Yanakie Isthmus, Wilsons Promontory National Park.

of the study, the Tea-trees and Flax-lillies had grown to around 0.3 m in height.

The area had not been burnt for 20-30 years and previous surveys in the vicinity had located the New Holland Mouse only in the dunes (Quin 1996). Since 1992, baiting with the poison 1080 has been carried out annually in the swales for the control of Red Foxes *Vulpes vulpes* and rabbits. Baiting for rabbits has been excluded from sites where the New Holland Mouse was known to occur. The baiting aims to reduce rabbit numbers and therefore assist in restoration of the Kangaroo Grass *Themeda triandra* native grassland-open woodland which formerly occurred over parts of the Yanakie Isthmus (Quin and Williamson 1996).

The weather throughout the survey period, May 7-9 1996, was generally cloudy and cool, with showers on the first two nights. The third and final night was clear and cold.

A total of 88 Elliott folding box traps (Elliott Scientific, Upwey, Vic.) measuring 33 × 10 × 9 cm was used. The survey concentrated on several dunes where New Holland Mice had been trapped earlier in 1996 (D. Carmen, *pers. comm.*) and adjoining swales, and included the site chosen for the proposed exclusion plot. Five lines of traps (63 traps) were positioned on or at the base of dunes, and four lines (25 traps) were positioned in open vegetation in the swales. Traps were spaced at 10 m intervals and baited with a mixture of peanut butter, honey and rolled oats. Traps were checked early each morning and then closed to prevent capture of diurnal animals. They were re-opened in the late afternoon, and rebaited where necessary.

Table 1. Total captures of small ground mammals during Elliott trapping at Yanakie Isthmus, Wilsons Promontory National Park, May 1996.

Date	New Holland Mouse Swales	New Holland Mouse Dunes	Bush Rat	House Mouse
7 May	4	10	3	0
8 May	7	15	2	2
9 May	3	10	3	1
Total	**14**	**35**	**8**	**3**

Trapping was carried out on three consecutive nights, realising a total of 264 trap-nights. The survey initially aimed to determine presence or absence of the New Holland Mouse in the study area. However, in view of the number captured on the first night, it was considered important to take morphological measurements thereafter. Weights of New Holland Mice were recorded on the second morning of capture; weight, gender, tail, and pes (foot) length were recorded on the third morning. A Pesola spring balance was used for measurement of weight, vernier calipers for pes measurement and a ruler for measurement of tail length. After examination, each individual animal was released at the location where it was captured.

Results

Three species of rodent were recorded during this survey: New Holland Mouse, Bush Rat *Rattus fuscipes* and House Mouse *Mus musculus*. Total captures for each species are shown in Table 1.

The overall success rate was 22.7%. The mean success rate for the New Holland Mouse was 19.3%. On 8 May the success rate for the New Holland Mouse was highest, at 25%.

Over the three nights, 14 (28.6%) New Holland Mice were captured in swale vegetation. On the first night, four New Holland Mice (28.6%) were trapped in the swales; on the second night, seven (31.8%) and on the third night, three (23.1%). No

Table 2. Morphological measurements for New Holland Mice captured at Yanakie Isthmus, Wilsons Promontory National Park, May 1996. *one individual not included as part of tail missing.

Measurement	Male				Female			
	mean	s.d.	range	n	mean	s.d.	range	n
Mass (g)	19.2	1.32	18-21	7	16.9	1.56	15.5-19.5	5
Tail length (mm)	94.6	8.22	80-105	7	91.5	5.07	85-96	4*
Pes length (mm)	16.7	0.25	16.5-17.2	7	16.4	0.47	15.7-16.8	5

House Mice or Bush Rats were captured in the swales; all were on or immediately at the foot of dunes.

One New Holland Mouse shed the last 35 mm of the skin of its tail while being handled. This technique is used by some rodents to avoid capture (P. Myroniuk, *pers. comm.*). Another had recently lost approximately one third of its tail (i.e. not only the outer skin).

Following their release, most New Holland Mice paused for three or four seconds before bounding away rapidly toward cover. One individual covered a distance of about 20 m in an estimated five-six seconds.

One of the 13 New Holland Mice trapped on the night of 9 May escaped before measurements or gender were recorded. Of the remaining 12, seven were males and five were females. Range, mean and standard deviation for all measurements are recorded in Table 2.

Discussion

The capture rate of New Holland Mice (19.3%) obtained in this survey was higher than that recorded by Quin (1996), whose work in the same area in February and April 1993 yielded 25 New Holland Mice from 157 trap nights (15.9%).

The vegetation in the swales may have been too low and sparse in 1993 to provide sufficient cover for the New Holland Mouse. Vegetative cover had increased since that time (B.R. Quin *pers. obs.*); this could be attributed to a reduction in grazing pressure due to the extensive rabbit baiting program. As a result, by 1996 the patchy Coast Tea-tree may have provided sufficient cover to enable the New Holland Mouse to venture into the swales. Alternatively, food abundance may have increased in association with the increase in cover. However, Carmen (*pers. comm.*) recorded breeding in May, so an alternative explanation may be that the New Holland Mouse population at Yanakie Isthmus was highest in May (see Kemper 1988) and competition had forced some mice into the swales.

The on-going baiting for rabbits and foxes, although peripheral to the New Holland Mouse population, may well be having a beneficial effect, leading to a higher population. Smith and Quin (1996) have demonstrated that some Australian rodents have undergone decline where feral predator abundance has been elevated by high levels of introduced prey species such as rabbits. Thus, more than one factor may be responsible for the apparent increase in size of the New Holland Mouse population.

Previous studies have demonstrated the preference of the New Holland Mouse for an actively regenerating (post-fire or post-clearing), heathy understorey (e.g. Wilson 1994; Braithwaite and Gullen 1978). The vegetation in the swales at this study site was at an early stage of succession following slashing. It is probable that in time, as Coast Tea-tree regrowth comes to dominate the site, thereby excluding other plant species, the area will become unsuitable as habitat for the New Holland Mouse as appears to have been the case at other sites on Wilsons Promontory (Quin and Williamson 1996).

The establishment of grazing exclusion plots alluded to in the introduction, was intended to be a management measure which might enable the New Holland Mouse to venture out of the dune vegetation as the *Themeda* grassland/woodland in the swales established sufficient cover. As New Holland Mice were found in the swales during this survey, and some captures occurred on the actual exclusion plot site, the proposal requires modification. (The planned grazing exclusion plot was established shortly after this survey took place.)

Future management for the New Holland Mouse should include systematic monitoring of their numbers, and monitoring of

vegetation under three different management regimes within and outside a much larger exclusion zone:

- an area of swale which is slashed every 3-5 years to keep it at a stage of succession which is currently believed to be suitable for New Holland Mice;
- an area of swale in which the Coast Teatree is left to regenerate, to determine the post-slashing regeneration age at which the mice are no longer present;
- an adjacent area of dune vegetation.

This should provide useful information on the effect of grazing by large herbivores on swale and dune vegetation composition and on New Holland Mouse population growth and distribution.

Acknowledgements
We would like to thank the following people who assisted with this project: Susan Taylor and Ross Williamson for supervision; Linda Rippon, Susan Taylor and Sonya Feodoroff for assistance with field work; Paul McDiarmid for information; and Gordon Friend, Darren Quin, John Seebeck, Susan Taylor, Ross Williamson and Wendy Williamson for constructive criticism of drafts of this report.

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Observations of Platypus *Ornithorhynchus anatinus* Mating Behaviour

Mark De-La-Warr[1] and Melody Serena[2]

Abstract
Only three instances of apparent Platypus mating behaviour have previously been described in the wild, with three additional examples of mating described in captivity. We report here on a presumed mating sequence observed in the wild at Lake Elizabeth in the Otway Ranges, Victoria. (*The Victorian Naturalist* **116** (5), 1999, 172-174.)

Introduction

Remarkably little is known about the reproductive behaviour of the Platypus *Ornithorhynchus anatinus*. Given that eggs have been recorded in underground nests from late August to October and that gestation and incubation are respectively believed to last about one month and ten days, Platypus presumably may breed as early as July, with some evidence that eggs appear somewhat earlier in Queensland and northern New South Wales than in Victoria (Griffiths 1978). To the best of our knowledge, the breeding behaviour of wild Platypus has previously been described by only two authors, with three additional accounts of mating recorded in captivity.

Verreaux (1848, quoted in Burrell 1927) witnessed two Platypus mating in the middle of a reed bed after the male had chased the female 'for nearly an hour'. The male gripped the female's neck with his bill and her hindquarters with his back legs. The

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female struggled violently and vocalised increasingly loudly ('plaintive cries rather like the squeaks of a young porker') until the pair separated after five or six minutes. Afterwards, 'the two animals played together for more than an hour'.

Burrell (1927) (who doubted the accuracy of Verreaux's observations) reported two separate incidents along the Namoi River in August 1909 and September 1921. In the first incident, one animal floated 'perfectly still' with its body and tail submerged below the surface, while the second approached slowly and then mounted the first 'in a leisurely fashion'. The second animal then 'threw himself back into a sitting posture' at which point 'there was a great splash, and both animals disappeared'. These events were directly preceded by the animals swimming in a tight circle at the surface for about one minute. In the second incident, two Platypus were initially observed 'floundering, or wallowing' at the surface, facing in opposite directions and upside down so the tail of each animal was laid flat along the other's abdomen. At short intervals, the animals rotated around their long axis (whence the floundering) so each could breathe in turn at the surface, with these manoeuvres undertaken 'in a calm, slow, deliberate manner, and almost noiselessly'. After three minutes, the pair separated underwater and then rose together to the surface before diving and disappearing from view.

In captivity, Fleay (1980) observed a pair mating on 1 October 1943. The interaction began with the animals swimming in processional circles in the tank, the male grasping the end of the female's tail in his bill. While still holding the female's tail, the male doubled his body under her to achieve intromission. The pair subsequently adopted the posture observed by Burrell along the Namoi River in 1921, facing in opposite directions and upside down relative to each other so they had to breathe alternately. The pair separated after ten minutes.

At Taronga Zoo in Sydney, mating sequences were recorded on 10 October 1990 and 11 October 1991 (Hawkins and Fanning 1992). In both cases, the male mounted the female by grasping her tail between one hind foot and his own tail (which was curled forward) while moving his body forward so his head lay over her shoulder. The animals were supported by a log lying approximately 10 cm below the water's surface, although in 1991 the female swam the length of the tank on several occasions while the male was mounted. The pair remained coupled for 17 minutes and 28 minutes, respectively.

We describe below a fourth example of presumed Platypus mating behaviour in the wild, observed on 28 September 1998 at Lake Elizabeth, Victoria.

Description of the Waterway

Lake Elizabeth is located 8 km southeast of the township of Forrest in the Otway Ranges (143°40'55" E, 38°30'45" S). The lake was formed in 1952, when a natural landslide dammed the East Barwon River, creating a waterbody which is about 800 m long x 200 m wide at its widest point and typically 4.5-6 m deep. The habitat surrounding the lake consists of wet sclerophyll forest and subtemperate rainforest dominated by Manna Gum *Eucalyptus viminalis* and Southern Blue Gum *E. globulus*. Since 1994, one of us (MDLW) has regularly conveyed small numbers of people around Lake Elizabeth by canoe, in order to observe the behaviour of a number of species living in and around the lake, including Platypus. Up to seven Platypus are seen over a period of two hours around dawn. The animals continue to feed and otherwise appear to be undisturbed by the presence of the boat as long as its occupants remain quiet and reasonably still when Platypus are at the surface.

The observations reported below were made on a sunny day following a windy, rainy night. After a long spell of dry weather, nearly 70 mm of rain had fallen in the previous three days, causing the lake level to rise.

Description of Mating Behaviour

Two Platypus were observed at approximately 0700 hours resting in 12 cm of water on a partly submerged hollow log (60 cm in diameter, with the hollow portion extending at least 2 m back from the entrance) located perpendicular to the bank along the shady northeast margin of the lake. One animal was lying on top of the other, with its bill moving slowly back and forth along the

other's back. The animals then began rolling over in tandem in a halting manner. Their bodies were pressed together closely, with their underparts mostly hidden by a tangle of legs as they rotated slowly. Both animals had their eyes shut and otherwise appeared oblivious to the presence of the observer's canoe, 8-10 m away.

After completing about four full rotations over a period of two to three minutes, the two Platypus separated and swam in a leisurely manner for a distance of about one metre to the exposed opening at the end of the log. After both animals entered the hollow, one turned around and used its bill to re-arrange some reeds growing around the entrance. The animal continued to manipulate the vegetation in a diligent manner for 30 to 40 seconds, until the opening into the hollow had been hidden from the observer's view. While it is known from radio-tracking studies that Platypus burrow entrances are often concealed from view by undercut banks, overhanging vegetation, etc. (e.g. Serena *et al.* 1998), this is the first time that a Platypus has apparently been seen actively disguising the entrance to a resting site. The log's location and orientation suggested that it may have led directly to a burrow in the bank. Alternatively, Platypus are occasionally known to shelter during the day in sizeable hollow logs at the edge of the water (Burrell 1927; M. Serena *pers. obs.*).

Discussion

Considered collectively, the accounts of Platypus breeding behaviour summarised above suggest that the following generalisations apply to this species:

(1) Platypus may mate either while supported by a structure in a few centimetres of water or while floating in deeper water.

(2) In shallow water, a pair will mate with the male mounted on top of the female. In deeper water, the animals may end up facing in opposite directions and positioned upside down relative to each other.

(3) A pair of Platypus may remain coupled for a few minutes to as long as about half an hour.

(4) Mating may be immediately preceded by the pair swimming in tight processional circles on the surface. In captivity, such circling behaviour has sometimes been recorded on a number of days in the breeding season (Strahan and Thomas 1975; Fleay 1980), possibly due to the animals being forced to share a relatively small space throughout this period.

Acknowledgements

We thank P. and C. Brown and T., V. and A. Rowe for helping to confirm the details of the observations reported here.

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Special Issues

Next year (2000) we will publish two special issues of *The Victorian Naturalist*.

One of the issues will celebrate the life and scientific work of **Sir Frederick McCoy** (1823-1899) on his centenary. Frederick McCoy was the first President of the Field Naturalists Club of Victoria and held this office for three years, from 1880-1883.

The second special issue will concentrate on **The Murray River**, its billabongs and creeks.

If you wish to contribute articles, research reports or notes to either of these issues, please contact the editor (FNCV, Locked Bag 3, P.O. Blackburn, Victoria 3130).

A Diary of the Saunders Casemoth *Oiketicus elongatus*

Joan Broadberry[1]

Abstract
This paper includes field observations of the larval and pupal stages of the male and female Saunders Casemoth *Oiketicus elongatus,* including method of climbing vertical surfaces, indications of eclosion, timespan of pupal stage and a description of winged male and wingless female moths. (*The Victorian Naturalist* **116** (5), 1999, 175-178.)

Observations of the larval stage

On Sunday 21 February 1994 I picked up a 15 cm long, twig-decorated case of a Saunders Casemoth *Oiketicus elongatus,* which had fallen out of a prickly Grevillea in our yard. These cases are quintessentially Australian. Most of us learn as children to recognise them, but beyond the mere act of recognition there is total ignorance. I consulted Coupar (1992), and found that casemoths are the larval or caterpillar stage of a moth, and as they are interesting to keep and observe, I installed the animal in an old esky and provided several food plants *Grevillea, Acacia and Eucalyptus*, not being sure of what it ate. I keep a regular nature diary, and the following account is from the field notes I made over the next year.

That evening I was home alone when I heard a faint noise. I'll never forget the delight of that first sight of the head and thorax of a handsome orange and black caterpillar. Initially we only caught glimpses of the caterpillar if we peeped quietly into the container. But the creature gradually became used to us and began to move around freely, somehow crawling up the vertical sides of the esky and attaching near the top. It always quickly closed its case for privacy when disturbed, but over time, this action became slower.

After a day or two we established the food plant as *Grevillea glabrata* by seeing the caterpillar eat it. By the way, the best sign of casemoth 'life' and activity are the faecal pellets (frass) lying on the bottom of its container. I took many photos of the orange head and black body segments, blotched with bright orange. Up to seven body segments came out of the case, the last three showing being totally black. On the thorax were three pairs of legs tipped with curved claw-like feet (Fig. 1).

A week later the casemoth became very restless, climbing the sheer sides of the esky again and again. It took us another week of observation to realise that the caterpillar climbs vertical surfaces by making a silken ladder, with steps about 7 mm apart. The animal builds each step by moving its head from side to side and laying down many strands of the silk secreted from its mouthparts. This becomes a rung of its ladder. The caterpillar, using its first pair of legs, then pulls itself and its stick case up, until its head projects beyond the rung. It stretches its head a further few millimetres and lays down another step. The whole process is repeated over and over again. The silken ladder left behind shows clearly where the casemoth has climbed.

Fig. 1. Larval stage of casemoth showing the caterpillar's head. Photograph by Joan Broadberry.

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More observations. I noticed the back end of the animal came right out of the case when faecal pellets were being expelled. While they feed, casemoths attach the top of their case to a twig with a few strands of silk. This is cut when they are ready to move on. The case can be very tightly shut by twirling it around a stick or pulling it inwards like an old-fashioned drawstring purse. Saunders Casemoths readily climb around in foliage using their strong, hooked feet to grip onto twigs, the body inside the case always being pulled behind.

I started reading Common (1990). The Saunders Casemoth belongs to a world-wide family of the Psychidae, commonly called case or bag moths. The family includes about 600 species with an estimated 145 found in Australia. *Oiketicus elongatus* occurs in Southern Queensland, New South Wales and Victoria in all seasons of the year. Each individual animal seems to have a preferred food plant, but the species is polyphagous and has been recorded on *Eucalyptus, Leptospermum, Melaleuca*, and introduced plants including *Citrus* and *Cotoneaster. Grevillea subsp.,* the plant our casemoth feeds on, is not mentioned as a food plant.

Casemoths go through many instars over a period of years, during which they seal up their cases, become inactive and shed their skin. This is known as ecdysis. The number of instars of the Saunders Casemoth is not stated. A study of a similar West Indian species, *Oiketicus kirbyi,* estimated 12 to 20 instars. On 10 March 1994 I observed that our casemoth appeared to be going through ecdysis. It had been hanging from the side of the esky for several days, not moving and producing no frass. An alternative explanation may be that the caterpillar was going through a period of diapause, a time of decreased metabolism. On 25 March the casemoth commenced feeding again and on 21 May we released the captive animal outside to live freely on its foodplant.

Observations of the male pupal stage

On 11 March my daughter found a second, smaller casemoth attached low down on a nearby telephone box and brought it home. After a couple of days, as it wasn't eating, I put it back in the tanbark about five metres from the phone box and forgot about it. However, this little creature was destined to play a much bigger part in our lives.

Some time later, on 23 March, I noticed a small casemoth hanging in the same place on the telephone box. It may have been the same one we found earlier because it was attached on exactly the same spot. It seems intriguing that it would 'home' to the identical place. Observing closely, I noticed it seemed shrunken inside. Looking carefully I realised there was an orange and black caterpillar head and thorax, detached and dangling below the case (Fig. 2). Reasoning that this might be a sign of pupation before the emergence of an adult, I took the case home and hung it inside a glass jar resting on a cool, south facing windowsill over the sink, where I would notice it every day. We just dared to hope for an adult moth, but realised it would require patience.

Sunday 12 October 1994. What excitement! My daughter had the honour of finding a perfect adult male casemoth inside the jar (see photo on front cover). Our patience had paid off. It was a truly beautiful moth and so seldom seen, although

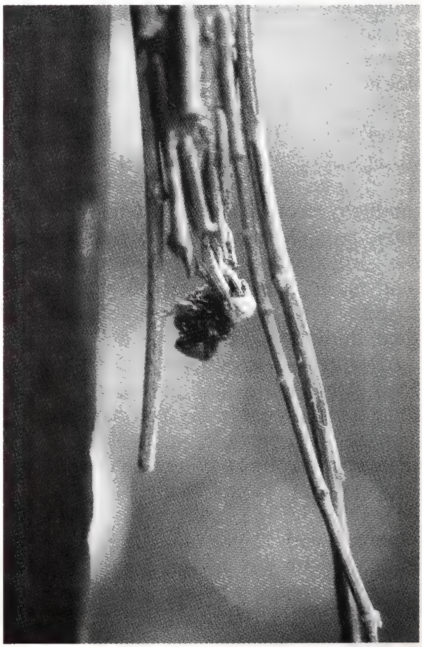

Fig. 2. Detached caterpillar head and thorax dangling below the twig case. Photograph by Joan Broadberry.

Fig. 3. Pupal case, after male adult casemoth has emerged. Photograph by Joan Broadberry.

Fig. 4. Female adult Saunders Casemoth, showing pupal case. Photograph by Joan Broadberry.

they must be common. It had a wingspan of 45 mm; a black furry body 26 mm in length; a long, pointed, orange and black striped abdomen; a large hairy orange patch on its back; and black antennae. The bold orange and black colour scheme echoed that of the caterpillar. The forewings were an elongated oval shape, transparent, with a bee-like texture. The hindwings were similar but much smaller. The two pairs of wings rested in a horizontal position.

The twig case had a dark, shiny cylindrical pupal case, open at the bottom, protruding from it (Fig. 3). Now, years later, I sometimes observe such cases, a sure sign the moth has flown. Regrettably, after being photographed the adult gave its life for science, ending as a pinned specimen. Mission accomplished. But there was to be a further chapter.

Observations of the female pupal stage

The large casemoth had been outside, lost in the prickly embrace of the Grevillea. During the colder winter months we made no observations at all, but we spotted it again at the end of October moving around the shrub.

On 14 January 1995 I recorded that the twig home measured 16 cm from tip to tip. This is considerably larger than the 12 cm maximum recorded in Common (1990). From my photographs of the distinctive case, there is no doubt it was the original animal. That day the caterpillar was very restless. It climbed part way up the house wall and attached near the front door. Next day we lost the animal, but tracked it by means of the silken ladder. The caterpillar had climbed the whole height of the house up to the eaves. Later it fell to the ground. Was it too heavy or was this the only way down? How do casemoths go backwards? This behaviour was observed off and on until 5 February when it finally climbed up to the middle of a low window and made a very strong attachment. I was able to get excellent views from inside the glass, of the movement of the head in making the ladder, and the awkward heaving of the heavy body up each silken step. That final journey took tremendous effort. More of the caterpillar body segments than I had ever seen previously came out of the case. Once secure, there it stayed, tightly closed.

Saturday 11 March. I became aware of a faint movement and a shiny yellow head just peeping out of the back end of the case. What was happening? The animal seemed the wrong way around as the female is fertilised inside the case and I would not expect the head to be at the rear opening. I was consumed with curiosity but the only way to look inside would have been to destroy the twig home. Again patience was required. Looking back now, I know this meant the caterpillar had turned into a mature, adult wingless female moth (Fig. 4). The pupal stage lasted only about five weeks, in comparison with the male's pupation, which took at least five months. I re-read Common (1990) more carefully. In the sub-family Psychidae, both male and female newly emerged adults turn inside the case, meaning the female genital organs are facing away from the rear opening. The male is able to greatly extend its abdomen to contact them. This is the origin of the species name '*elongatus*'.

On 21 March I noticed that the rear end of the case was gaping open, and glancing at the ground, saw a fat, yellowish grub-like animal lying there. Because I had ear-

Fig. 5. Part of a colony of casemoths containing over 70 individuals. Photograph by Joan Broadberry.

lier glimpsed its head, I realised this was the wingless adult moth. It was a very happy occurrence, as I would never have damaged the case to see the animal. Again great excitement, as I photographed the live female Saunders Casemoth.

The wingless moth, 6 cm long, looked just like a bloated yellow Egyptian mummy, with a large mustard coloured head. The body texture was smooth, with five indistinct segments covered by very loose baggy skin. The moth was very swollen, with its ovipositor extended from a brown furry ring around its rear opening. Its helpless body heaved and pulsated in a wave-like motion starting from the head and travelling to the back. Three pairs of minuscule legs were just visible below the head, but the creature was not designed to walk or fly, simply to spend its whole life inside the protective case.

Next day I cut the empty twig case open for photographs. Inside was a velvety soft silk lining and the remains of a black, shiny, tube-like pupal case similar to the one I had seen protruding after the male moth emerged. The animal had pupated head up, but must have turned after emerging from the pupal case. Later, I decided to replace the moth in its damaged home and leave it out overnight, just in case eggs were laid. The most exciting thing of all would be to watch them hatch and see tiny Saunders Casemoth larvae start to build their homes. But it was not to be, and the wingless female died about 26 March. In Common (1990), I read, 'Sometimes the spent female is said to drop from the case after oviposition.' The female had probably been fertilised and laid the eggs of the next generation, before dropping from the case.

Directions for the future investigation

There are many more aspects of Saunders Casemoth biology to explore: the number of instars and lifespan for example. The significance of the dangling remains of the head and thorax is not yet clear. It seems to be an indicator of eclosion in the male animal. I have observed this sign on two other occasions, collected the cases and in both instances, after some time, a male moth has emerged.

I continue to learn. In a recent interesting encounter with the Saunders Casemoth we found a group of over 70 individuals clustered together on a Cypress tree in an inner suburban garden (Fig. 5). In this colony I found two cases fused together. Each contained a healthy caterpillar, but the two were forced to move about together, like Siamese twins, as their cases were joined (Fig. 6). This large group raises the question of how gregarious the caterpillars are?

Studying this unique Australian animal is a fascinating part of my life. It is seemingly so common but also so secretive. The caterpillar and female moth, always hidden from our eyes inside the case, and the male, so elusive that few photographs or specimens exist.

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Fig. 6. Larval stage of casemoth, showing two twig cases fused together. Photograph by Joan Broadbury.

New Records of the Striped Worm-lizard *Aprasia striolata* in South-western Victoria

Cam Beardsell[1], Nick Clemann*[1], John Silins[1] and Edward McNabb[1]

Abstract
The Striped Worm-lizard *Aprasia striolata* has been infrequently recorded in Victoria, and is officially listed as a threatened species. This article reports two new localities for this species in south-western Victoria. One individual was captured in an invertebrate pitfall-trap in heathy woodland south of Edenhope. Nine adults and five juveniles were hand-caught after being located beneath limestone slabs in the Glenelg River gorge south-west of Casterton. Numerous sloughs of this species were also discovered beneath rocks at this site. Sympatric reptiles species noted during brief surveys at both sites are listed. (*The Victorian Naturalist* **116** (5), 1999, 179-180.)

Introduction

The Striped Worm-lizard *Aprasia striolata* Lutken 1863 is a small, worm-like pygopodid (legless) lizard, adapted to burrowing in loose sandy or loamy soils (Cogger 1996) (Fig. 1). It has two main distributions in semi-arid regions of southern Australia (Cogger 1996). One is in the south of Western Australia, whilst the other extends from Portland to the Big Desert in western Victoria across South Australia to the Eyre Peninsula. Populations within this range may be localised and fragmented due to natural discontinuity in habitat and land clearing.

Aprasia striolata has been infrequently observed in Victoria and is officially listed as Lower Risk – Near Threatened (NRE 1999). In recent years (1990-1998) there have been only three records of this species. Similarly, for the period 1970-1990 there are 11 records and, prior to 1970, another 11 records (Atlas of Victorian Wildlife database, NRE). Most records have come from sand-hill mallee communities of the Little and Big Deserts. There is a scattering of records from heathy woodlands in the Edenhope-Casterton region, with an outlying population on limestone cliffs along the southern coast around Portland. This note reports two new records detected in summer– autumn 1998/99, during fauna surveys for the Regional Forest Agreement Process. These were of a single animal captured in an invertebrate pitfall-trap south of Edenhope and a population located during searching of the Glenelg River gorge south-west of Casterton.

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Habitats at the new sites

The Edenhope site was at the northern end of an extensive sand-plain which extends south-west to the South Australian border. To the north lie the Wimmera Plains which once supported grassy woodlands, though they are now largely cleared for grazing and cropland. Heathy woodland on the sand-plain contained an overstorey of Desert Stringybark *Eucalyptus arenacea*. The heathland understorey consisted of tall shrub copses of Desert Banksia *Banksia ornata* and a moderately dense stratum of low shrubs including Heath Tea-tree *Leptospermum myrsinoides*, Daphne Heath *Brachyloma daphnoides* and Flame Heath *Astroloma conostephioides*. The ground stratum consisted of sedges including Tassel Rope-rush *Hypolaena fastigiata* and Black Rapier-sedge *Lepidosperma carphoides*.

In the Glenelg River gorge, *A. striolata* occupied limestone cliffs, escarpments and upper river terraces. The overstorey consisted of an open shrubland of Drooping Sheoke *Allocasuarina verticillata*, Wedge-leaf Hop-bush *Dodonaea cuneata* and Tree Violet *Hymenanthera dentata*. The ground stratum on the escarpment consisted of an open tussock grassland dominated by Grey Tussock-grass *Poa sieberiana* and Rough Spear-grass *Austrostipa scabra*. The terrace supported a closed grassland of Common Tussock-grass *Poa labillardieri*. Cliffs were formed of horizontal bedded limestone while small, flat slabs lay on the escarpment. Rock screes occurred on the terrace at the foot of the cliffs. Soil consisted of friable brown alluvium.

New records of the Striped Worm-lizard

A single *A. striolata* was captured in an invertebrate pitfall-trap near Edenhope. It had a snout-vent length of 92 mm, and a tail length of 31 mm. Other reptile species recorded at this site included Garden Skink *Lampropholis guichenoti*, Bougainville's Skink *Lerista bougainvillii*, Eastern Three-lined Skink *Bassiana duperreyi* and Tree Dragon *Ampibolurus muricatus*.

Fourteen *A. striolata* were located under limestone slabs in the Glenelg River gorge during a 90-minute search by the authors on 25 March 1999. Nine of the individuals were adult (one collected, Fig. 1) and five were juvenile. Numerous shed skins (sloughs) were also observed beneath the slabs. A single animal was captured during a brief search of the same area the previous day. Sympatric reptiles recorded during the search of the Glenelg River gorge included Common Brown Snake *Pseudonaja textilis* (two juveniles), Bougainville's Skink (two adults), Garden Skink (three adults) and Southern Grass Skink *Pseudemoia entrecasteauxii* (four adults). This site was private property which retained most of its original vegetation and had not been subjected to ground disturbance. These factors probably account for the persistence and density of the lizards in the area.

Acknowledgements

The field work was a component of the Regional Forestry Agreement wildlife survey of western Victoria. The authors thank Ivor Graney of the Portland Field Naturalist Club who drew our attention to the presence of unspecified worm-lizards in the Glenelg River gorge. Geoff Brown and Richard Loyn, both of the Arthur Rylah Institute, provided helpful comments on the manuscript.

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Fig. 1. The Striped Worm-lizard *Aprasia striolata*. Photo by Nick Clemann.

Early Devonian Fossils from Eglinton Road and Rail Cutting, Alexandra, Central Victoria

Clem Earp[1]

Abstract

A brief report is given of an allochthonous fossil assemblage of Pragian (Early Devonian) age from marine shale at a location near Alexandra, central Victoria, Australia. The fossils include large early land plants, of which illustrations are given of an unnamed species, possibly related to *Drepanophycus* (Lycophytina, Drepanophycales). Rare shelly fossils include *Hercynella* (Mollusca, Bivalvia); the literature relating to this genus is reviewed. (*The Victorian Naturalist* **116** (5), 1999, 181-186.)

Introduction

Eglinton Cutting is a large road cutting approximately 4 km northwest of Alexandra on the Goulburn Valley Highway (Fig. 1). At the crest of the road, another cutting branches off to the northeast; this was formerly the line of the Yea-Alexandra railway.

In 1994, the local council reduced the slope on the south side of the cutting to prevent rockfalls. On inspecting the new face, I found that numerous fragments of the Siluro-Devonian fossil plant, *Baragwanathia*, were visible. On subsequent visits, I found a number of other fossils, mostly in the talus left by the road works. Some of these fossils are described below, others are still under study. Those figured in this paper are deposited with the National Museum of Victoria (indicated by NMV specimen numbers).

Previous studies

The area was examined in 1929 by a team of geologists from the Mines Department, who were specifically looking for *Baragwanathia* and associated graptolites. The north end of the cutting (road and rail combined) was referred to as location 8 in the published report by Harris and Thomas (1941), and the railway cutting was referred to as location 9.

Location 9 produced specimens of graptolites and *Baragwanathia longifolia* occurring together, which were pictured by Lang and Cookson (1935) in the first description of this species. At location 8 however, Harris and Thomas reported only a succession of basal shelly 'grits', overlain by sandstones, and mudstones containing *Monograptus*.

The shelly fossils collected in 1929 were subsequently examined by Dr. J. A. Talent, who identified the brachiopods *Boucotia australis* and *B. loyolensis*, as well as noting the occurrence of indeterminable gastropod remains (Couper 1965). On this basis, Couper (1963) considered the horizon at location 8 to represent the Flowerdale Sandstone Member of Williams (1964).

As for the graptolites, location 9 is one of the original localities for the species *Monograptus thomasi* Jaeger 1966 (see also Jaeger 1967). A specimen from Eglinton Cutting was figured by Garratt and Rickards (1984, fig. 5E).

Lithology

The new south face of the cutting exposes a stratigraphic thickness of nearly 40 m (Fig. 2). The rock is almost entirely thin-bedded light to dark grey mudstone, weathering to a buff colour at the top 2-3 m of the cutting. The beds dip uniformly at around 82° to the southeast, and strike at about 130°. Near the top of the exposure are two beds of massive ungraded fine-

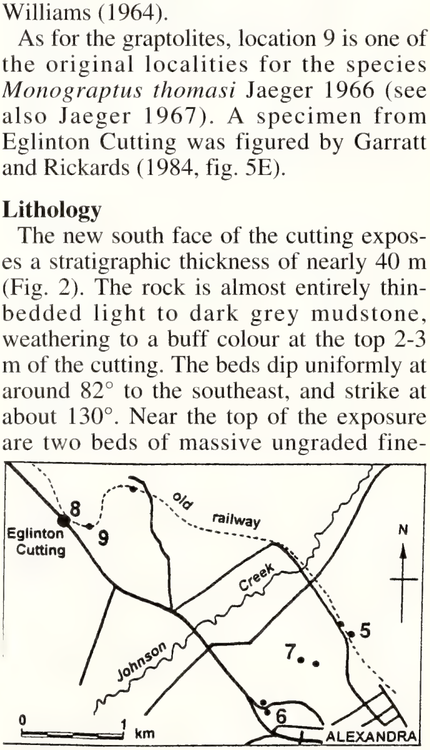

Fig. 1. Small dots show fossil localities north of Alexandra, from Harris and Thomas (1941), redrawn on a modern map base. The large dot (8) shows the location of the Eglinton Road and Rail Cutting.

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grained quartzitic sandstone, 15 and 30 cm thick, separated by 60 cm of mudstone.

The thickness of the mudstone beds varies from millimetres up to about 15 cm, but is most commonly in the range 6-9 cm. Many of these thin beds are graded, with siltstone (sometimes very fine sandstone) and minor current-bedding at the base, fining up to laminated claystone at the top. The contacts between the beds are usually planar and often marked by a millimetre-thick iron oxide stain; this is taken to represent oxidation of sulphides from organic matter which settled at the top of the bed. The lithology indicates deposition by turbidity currents in quiet, deep water.

I have not closely examined the north side of the cutting, which is now overgrown and weathered, except to note that the bedding and structure are more complex.

I have been unable to find any 'grits' (coarse sandstones and granule conglomerates) corresponding to those seen by the Mines Department geologists in 1929. This can be accounted for by the vastly altered nature of the cutting. In 1929 the road would have been little wider than a modern single lane. It is now a four-lane highway, with a parking area equivalent to a fifth lane. Clearly, an enormous amount of material has been removed from the south side of the cutting.

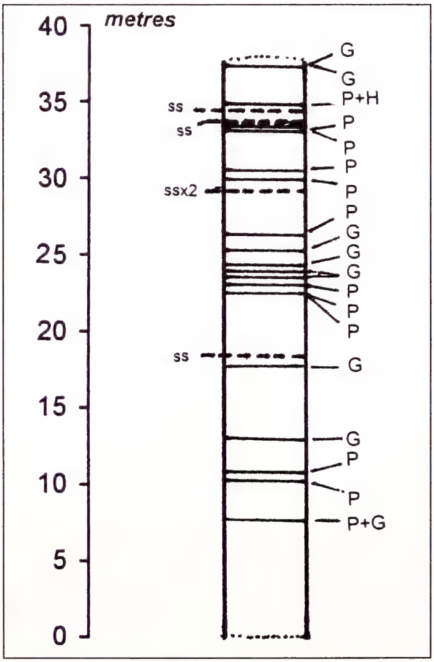

Fig. 2. Stratigraphic column, south face of Eglinton Cutting. G – graptolites, P – plants, H – *Hercynella*, ss – sandstone.

The strata are part of a marine shale sequence, at least 500 m thick, to judge by exposures to the south of Alexandra. This sequence, in turn, belongs in the formation known as the Norton Gully Sandstone (VandenBerg 1975). The name is somewhat misleading, by the way, as the formal definition states: 'The predominant type consists of claystone and siltstone shale with thin bedded fine sandstone'. This describes the observed facies exactly. The relationship between the Norton Gully Sandstone and beds previously assigned to the Flowerdale Sandstone Member is currently under investigation (see e.g. Edwards *et al.* 1997).

Palaeontology

General remarks

All the fossils I have so far found have been on the bedding planes between mudstone layers. I have seen none in the sandstone, whereas at Mt Pleasant, on the other side of Alexandra, where the lithology is very similar, it is the thin-bedded sandstones which are known for their plant fossils, while the mudstones are barren (Cookson 1935).

The stratigraphic distribution of known fossil horizons is shown in Fig. 2. Although the fossil biota is rather scanty, the locality in this paper shares some species with localities in the Lilydale district. Numbers given in the following text for the Lilydale locations correlate with those on a chart in Garratt (1983, fig. 5). Most localities from the Lilydale district comparable with the locality in this study are well into the *Boucotia loyolensis* zone, suggesting an age younger than that for the Flowerdale Sandstone Member (Garratt 1983, fig. 6).

Flora

Numerous fossil plant remains have been exposed; they include vague carbonaceous films, well-preserved coalified compressions, mineralized impressions and leached-out moulds. The better preserved specimens will be described at a later date;

for now a brief summary will be given.

Baragwanathia longifolia Lang and Cookson.

Very common; occasional specimens can be definitely identified in at least five different horizons, ranging from the top to the bottom of the cutting. Sometimes all that can be seen is a vague outline of an arched branch, at other times there are splendidly foliaceous specimens with coalified remnants.

Hedeia corymbosa Cookson.

As well as a couple of isolated stems, the site has yielded a substantial specimen with more than 20 sporangial heads. This is thought to be the largest specimen of *Hedeia* yet found (J. G. Douglas *pers. comm.*).

Yarravia cf. *oblonga* Cookson.

A single stem 12 cm in length with poorly preserved sporangia appears identical to one described by Cookson (1949, Plate 4, figs. 4 and 5) from location G1, Lilydale. These forms are more slender overall than *Y. oblonga* Lang and Cookson *sensu stricto*.

Zosterophyllum? sp.

Thin axes up to 10 cm in length, occasionally branching dichotomously. No connected sporangia have been found, the suggested assignment is based purely on the appearance of the axes.

Unknown tracheophyte.

Naked stems 5-15 mm diameter, one of which has a pseudomonopodial branch 7 mm in diameter. There is a prominent vascular trace. More frequent short branches 2-3 mm in diameter and 2-3 cm long occur at intervals, often springing from the same locus, in a K-configuration (Fig. 3). These seem to terminate in club-shaped endings, which are sometimes surrounded by a halo suggesting the remains of a globose structure, or in other instances, there seem to be a number of short, erect sporangia-like objects attached (Fig. 4).

This last species I regard as identical to plants found in the Wilson Creek Shale at Frenchman's Spur, described in manuscript by Tims (1980). Tims assigned the species to the zosterophylls on the basis of their branching, but the size and appearance of the specimens is so remarkable that this hardly seems likely. Specimens with larger diameter axes somewhat resemble an Eifelian (Middle Devonian) plant, *Drepanophycus devonicus* Weyland and Berendt, as illustrated by Schweitzer and Giesen (1980), but the secondary branches are significantly longer in our specimens (Fig. 5).

Fauna

The observed fossil fauna consists of abundant graptolites, and a very few isolated, more or less complete brachiopod and bivalve shells. The latter are relatively large (smallest diameter > 1 cm). Whereas the graptolites have left substantial carbonaceous remains, the shelly fossils are reduced to impressions, which leads to difficulty in identification. All fossils are highly compressed parallel to the bedding, and there is a further component of distortion which is most obvious in the graptolites (Jaeger 1966).

Although the very rare brachiopod and bivalve shells may have been directly emplaced by turbidity currents, little sup-

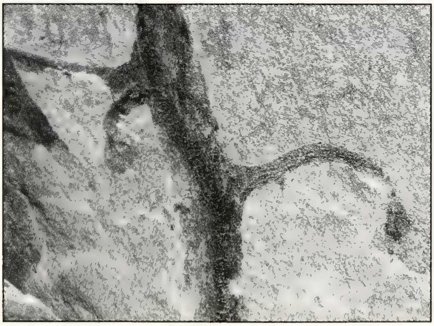

Fig. 3. Unnamed tracheophyte, NMV P208597A. Detail of two secondary branches in K configuration, ×1.75. At left, a third branch originates from the opposite side of the axis.

Fig. 4. Another detail from NMV P208597A, ×2.5. Single branch with possible sporangia on the clavate termination.

porting evidence for this mode of deposition is present. The size of the shells is anomalous in the fine sediments. There are no coarse sand grains, lithic clasts or broken shell fragments which one would expect to be entrained by currents sufficiently strong to carry the large complete valves. I consider the association with the abundant drifted fossils, such as the land plants, to be significant, and suggest that these shells were rafted by epibiotic seaweed and dropped into position.

Graptolithina
Monograptus thomasi thomasi Jaeger.

This is observable at intervals at all levels of the cutting (Fig. 2). This well-known index species fixes the age of the rocks as Pragian – for a recent discussion see Carey and Bolger (1995).

Brachiopoda
Fascicostella? sp.

A battered fragment of an external mould shows coarse angular ribs arranged in bundles of 3, the middle being more prominent, at either side of a central area occupied by a panel of finer ribs. This type of ornamentation is characteristic of the Resserellinae (Walmsley and Boucot 1971). Two species of this subfamily have previously been reported from the Lower Devonian of Victoria. Of these, the one with coarse ornament is a *Fascicostella*, which Gill (1942) considered identical to specimens from New Zealand, then called *F. gervillei*, but now known as *F. batonensis* Walmsley and Boucot. Gill reported this species from locations G7, G9, G20 and G21 at Lilydale.

Two other brachiopod specimens have been found, but the impressions are not clear enough to be identifiable.

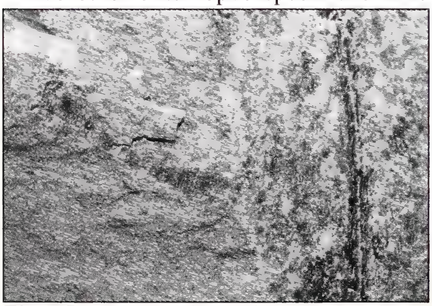

Fig. 5. Unnamed tracheophyte, NMV P208598A. Detail of a single branch with clavate termination, originating from a thick axis; ×2.

Mollusca (Nautiloidea)
Geisonocerina? sp.

Two poorly preserved specimens were encountered in this study. One is a faint impression which shows the apical 6 cm of an orthoconic nautiloid conch with the numerous transverse striae (8-10 per cm) common in this genus. Although *G. australis* Chapman has been recorded from the Norton Gully Sandstone at 'Kelly's Hill' (Mt Matlock), it differs from the specimens examined in this study by having nodular rather than smooth striae (Chapman 1912).

Mollusca (Bivalvia)
Hercynella killarensis Gill.

Two reasonably clear impressions of right valves, both having the hinge portion missing. One of these was the only shelly fossil found in place within the outcrop exposure; it was concave side up. In the field, *Hercynella* is easily recognised as a large, almost circular shell with one radius marked out by a low ridge (Fig. 6). *Hercynella killarensis* was originally described from location G35, Killara, near Lilydale (Gill 1950). *Hercynella* also occurs at Seymour in a very similar lithology (Schleiger 1964).

Notes on *Hercynella*

The previous Victorian papers on *Hercynella* were written at a time when it was thought to be a gastropod. This

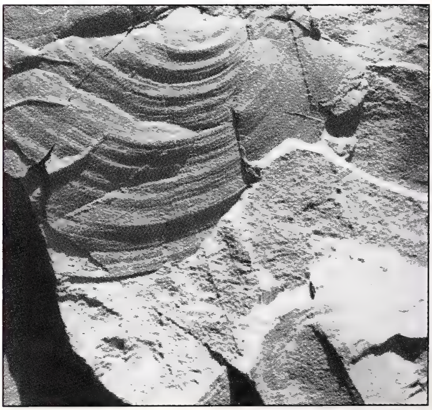

Fig. 6. *Hercynella killarensis* Gill, NMV P303521A. Inner mould of a right valve, ×0.625. The anterior ridge, at upper right, is intact only in its central half.

includes two palaeo-ecological studies (Chapman 1917; Gill 1950), and one can appreciate that the ecology of a bivalve may very well be different from that of a gastropod. As the overseas literature is relatively inaccessible, I think it worthwhile to summarize it here.

Hercynella is thought to have evolved during the Upper Silurian from the genus *Silurina*, by migration of the apex of the shell from its normal place at the margin, towards the centre (Termier and Termier 1950). The two genera are members of the family Antipleuridae. *Hercynella* is found in Europe, North Africa and North America as well as in Victoria, and was considered characteristic of the Old World faunal province of the Early Devonian by Forney *et al.* (1981).

Following the discovery of articulated specimens at a couple of European locations, Prantl (1960) emended the original diagnosis of Kayser (1878) as follows (my translation):

> 'Homomyarian, with strikingly inequivalve asymmetric shells with a subcentral to submarginal summit. The shells are subconical to clypeate, with a prominent anterior wing. The wing is convexly arched on one radius, forming a ridge along its course from the summit to the hinge. The hinge is curved inwards with a prominent external ligament groove. The pallial line is entire.'

It should be added that the valves are edentulous. The external ornament consists of concentric growth lines, and in some species a radial sculpture (e.g. *H. victoriae* Chapman, illustrated by Gill 1950).

The anterior ridge mentioned in the diagnosis is referred to in the older literature as a 'fold', a term more appropriate to gastropods. It is perhaps the location of the byssal gland (Termier and Termier 1950), but my personal opinion is that it serves some function analogous to that of the posterior ridge in many other bivalves.

Following the recognition of the genus as a bivalve by the Termiers, Prantl (1960) observed that there were numerous instances of pairs of similar species reported from the same location. Given the inequivalve nature of known articulated specimens, he suggested that these pairs of species represented opposing valves of a single species. One of his examples is the pair *H. petasoida* and *H. killarensis*, which Gill (1950) described from the same location; but any conclusive proof must await the discovery of an articulated specimen.

As regards the ecology of *Hercynella*, it is now believed that this genus followed a reclining mode of life in deep water (Kríz 1979, 1984). By 'reclining', it is meant that the shell was lying on or just beneath the sediment surface, with the sagittal plane at an oblique angle to the vertical, and without a strong, permanent byssal attachment (Stanley 1970, p. 35-36). Kríz (1984) considered *Hercynella* to represent the perfection of a trend among the Antipleuridae towards the reclining lifestyle. Members of this family began life as equivalved semi-infaunal juveniles attached to the substrate by a byssus. As they grew, one of the valves (randomly left or right) became lower than the other as the oblique position demands. The lower valve developed a conical shape (cf. *H. petasoida*) while the upper became more flat and lid-like (cf. *H. killarensis*); left and right valves are to be found equally among either form.

Conclusions

The fossils reported in this paper represent the remains of species which were free-swimming (nautiloids) or floating marine organisms (graptolites), or which drifted out to open sea, either on their own (plants) or attached to floating debris (the rare molluscs and brachiopods). On settling to the ocean floor, they were buried by deposition from turbidity currents, which at this location consisted of very fine sediment, indicating some distance from land.

Acknowlegements

The author wishes to thank N.W. Schleiger and J.G. Douglas for their comments on an early draft of this paper; thanks are also due to an anonymous referee for suggesting clarification of some points.

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One Hundred Years Ago

A report of the botanical results of the excursion to Cheltenham on Saturday, 19th August, was read by the leader, Mr. C. French, jun., who stated that a very interesting afternoon had been spent. Some twelve varieties of orchids had been noted in bloom, besides numerous other plants. On one of the orchids a parasitic fungus new to science had been found. Mr. J. Stickland stated that those members inerested in pond life had also experienced a profitable outing, as among other captures were the males of the rotifers *Lacinularia pedunculata* and *L. elliptica*, which are somewhat uncommon.

A paper was read by Mr. D. M'Alpine, entitled 'Description of a New Parasitic Agaric.'

The author described a new species of fungus of the genus *Hebeloma* (Agaricaceæ), which had been found by Mr. C. French, jun., during the Cheltenham excursion, growing on the stem of an orchid, *Pterostylis pedunculata*, R. Br., it being most unusual for a *Hebeloma* to be parasitic.

From *The Victorian Naturalist*
XVI, October 5, 1899.

Australia's Flying Frogs?

A number of 'flying frogs' are known from around the world e.g. *Litoria graminea* from New Guinea (Tyler 1976), *Hyla miliaria* from Mexico (Pough *et al.* 1998) and *Rhacophorus pardalis* from Indonesia (Heusser 1974). A detailed analysis of gliding performance by two species of *Rhacophorus* frogs has been published (Emerson and Koehl 1990), but to my knowledge no-one has investigated the gliding (or parachuting) abilities of Australian frogs. If a frog is able to fall at an angle less than 45 degrees it is said to glide whereas if the angle is greater than 45 degrees it is said to parachute (Pough *et al.* 1998).

While examining a live specimen of a large Peron's Tree Frog *Litoria peronii* from north of Wagga Wagga, New South Wales, it took a flying leap off my desk and landed about a metre away on the curtain. There was nothing special about that except that it appeared to land a little higher on the curtain than what I thought it should have done, given the take-off velocity and initial trajectory. I decided to investigate further and observed several jumps. On close examination of the frog I found an axillary webbing which stretched from approximately mid-body almost to the elbows. The photograph (Fig. 1) shows this webbing which is slightly less than fully extended here. Furthermore, the spreading of this webbing appeared to be under voluntary control. As the muscle involved in the stretching of the axillary webbing has an origin in the lateral body wall and an insertion in the distal humerus area, it may represent a component of the pectoralis muscle. When subjected to a simple stretch reflex by drawing the foreleg forwards (as might occur naturally when a frog was in flight or about to land) the webbing was extended briefly and then partially relaxed. At maximum extension the webbing appeared to pull the sides of the abdomen out a little too, so that the effective increase in planing area stretched almost from the groin to the elbows.

Fig. 1. Peron's Tree Frog *Litoria peronii*, Wagga Wagga, N.S.W., showing axillary webbing. Photo by T. Annable.

The efficiency of gliding depends on a number of factors such as mass, velocity, drag, shape of planing surfaces, angle of attack as well as the dimensions and orientation of the planing area. The axillary webbing of *L. peronii* together with finger and toe webbing and the head, body and limb surface areas is significantly less than in the oriental flying frogs (e.g. *Rhacophorus* species) which are able to glide up to 15 m or more at an angle of about 18 degrees (Pough *et al.* 1998), but certainly sufficient in my opinion to give significant lift. Whether the frog was gliding or parachuting is not certain as the angle of fall appeared to be close to 45 degrees. Unlike *Rhacophorus* species the interdigital webbing is not extensive in *Litoria* species.

Whether the frog can actually steer in flight with this webbing is another interesting question. The fact that the webbing has voluntary muscle control suggests the possibility. The excellent diurnal and nocturnal vision of these frogs would certainly be a very useful adjunct to controlled gliding. Such an ability would be very useful in the high, swaying branches of trees in which the species lives. Examination of several other arboreal or semi-arboreal *Litoria* species (Green Tree Frog *L. caerulea*, Eastern Dwarf Tree Frog *L. fallax*, Bleating Tree Frog *L. dentata* and Jervis Bay Tree Frog *L. jervisiensis*) shows they all have extensible axillary webbing to varying degrees, but whether all *Litoria* species do is not known. Other questions needing investigation involve a comparison of the terrestrial and arboreal species of the genus *Litoria*, bearing in mind that the genus as currently accepted is probably

polyphyletic (Cogger 1996); also whether or not other hylid frogs possess a similar structure. More detailed research on structure and function with high-speed cinematography and moving targets is needed to clarify this interesting phenomenon.

Acknowledgement
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Southern Right Whale in Port Phillip Bay

Southern Right Whales *Eubalaena australis* are regular visitors to Victorian waters. They migrate from their summer feeding grounds in the sub-Antarctic to the coastal waters of southern Australia during late autumn/early winter and remain until mid-late spring. The coastal range is from about Perth, WA to Sydney, NSW.

In the 1830s and 1840s, the annual visits to shallow bays in western Victoria and Wilsons Promontory were the basis for an intense shore-based whaling industry. Indeed, the first settlement in Victoria was at Portland Bay and focussed on this natural resource. The intensity of the hunting soon reduced the numbers, although Southern Right Whaling continued until the 1950s – but not in Victorian waters – and the species came very close to extinction. It is now estimated that there are about 6-800 Southern Right Whales in Australian waters during the winter months. The largest concentration of these is at the Head of the Bight, in South Australia, where some 200 animals may congregate. Southern Right Whales are fully protected under State and Commonwealth legislation. In Victoria, the species is listed under the *Flora and Fauna Guarantee Act* 1988 and management and conservation actions have been prepared and were recently published (Seebeck *et al.* 1999) in a formal Action Statement.

The principal Victorian site is centred on Logan's Beach, just east of Warrnambool, a regular calving and nursery area. Numbers of whales present vary from year to year; in 1997 there were five adults and a calf, in 1998 three adult females, each with a calf. An observation platform has been built and many hundreds of people watch the whales each season. The Department of Natural Resources and Environment (NRE) closely monitors the whales and collects and collates sightings of the species from other places along the Victorian coast.

In August 1998, a Southern Right Whale paid a visit to Port Phillip Bay. This was an unusual occurrence; since 1977 there have been four records of this species in the Bay – August 1977, July 1988, May 1989 and August 1992. All these involved single animals. There is no evidence to suggest that Southern Right Whales have been anything more than occasional visitors to the Bay, even at the beginning of European settlement.

The animal was first observed close to the shore in the Mornington/Mt Martha area on Saturday 1 August, and reported to NRE Fisheries and Wildlife officers during the weekend. It was not reported on 3 August, but on the following day was seen cruising along the coast between Martha Point and Balcombe Point. It was only some 10-15 m offshore for much of the

time, and excellent video footage and still photographs were obtained. The characteristic callosities on its head were clearly visible, as was a diamond-shaped white mark on its back. The pattern of callosities is unique and is used as the basis for identification of individuals. A National Photographic Index is maintained for all Southern Right Whales, to help in population monitoring. Many of these photographs are obtained using extensive aerial surveys for the species, or at congregation sites such as Head of the Bight. All the whales which visit Logan's Beach are photographed from the air by local NRE staff.

I visited Mornington on 5 August. The whale had been seen off the Mornington Jetty earlier that morning, but had left and was reported to be heading up the Bay. Over the next couple of hours I followed the steady stream of whale watchers to various vantage points along the coast and had good views of the animal. It was swimming quite rapidly, about 3-400 m off the coast and I last saw it off Olivers Hill at Frankston. It was seen that evening in the shipping channel off Black Rock.

On 6 August, NRE mounted a shore search and the whale was located in Sorrento Harbour in the afternoon, at which time its presence caused the Sorrento-Queenscliff ferry to delay berthing for a short while until the whale moved out of the way. At sunset, it was seen heading north, off Blairgowrie.

Despite a 3-1/2 hour flight by NRE officers on 7 August, during which the Bay was searched intensively, the whale was not seen again, and it is presumed that it safely left the Bay late on 6 or early on 7 August.

Several points emerge from this event. Probably the most exciting was that so many people were able to get a good look at the animal, which was often very close to shore. Many people did as I did, and followed the whale from vantage point to vantage point along the coast. The regulations that are in place to protect whales from interference by boats or aircraft were obeyed, with only a couple of boats venturing too close and having to be warned. Media interest was high, with television, radio and newspaper stories over several days. Other than some minor traffic congestion, whale watchers were able to share this rare event in a great spirit of cooperation and wonder.

NRE's Port Phillip region were responsible for managing issues of concern, but were only required to maintain their watching and recording role, and the many staff involved in this exercise have helped the community to experience a truly great natural event.

Acknowledgements
Rod Barber and Bob Hutton, from NRE's Mornington office, were instrumental in recording the movements of the whale, obtaining video footage and managing the public. Bob Warneke provided comment on early records of Southern Right Whales in Victorian waters. The Atlas of Victorian Wildlife database provided records of the species in Port Phillip Bay, and the account in *Mammals of Victoria* (P.W. Menkhorst, ed., p. 195) and the Action Statement (Seebeck, J., Fisher, J., Warneke, R. and Lowe, K. 1999, Action Statement No. 94, Southern Right Whale *Eubalaena australis*, NRE: Victoria) the relevant background material.

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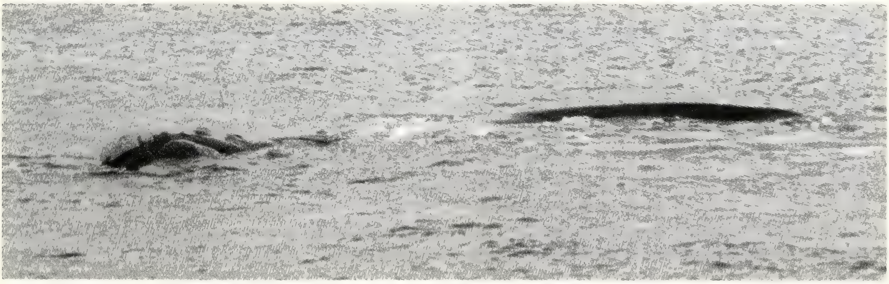

The Southern Right Whale near Mornington, August 1998. Note the callosities on the whale's head. The white patch on its back is just visible. Photo by Rod Barber, NRE, Mornington.

The Weaver

Autumn is my favourite time of year. The mild, drawn out, in the main sunny days, followed by cool or comfortably warm evenings. Often wind free or perhaps with just a gentle breeze. It is almost as if nature is having a rest in preparation for the heavy work it has to do in winter.

Describing permaculture gardens around the world, a series of ABC TV programs during January gave me a renewed interest in my garden. To see what I would have to do to turn my backyard into a permaculture plot, I went for a walk. Frankly, what I saw was a wilderness, the grass under the apple tree was up into the branches. But there was also a great surprise. For the apple tree was struggling with an enormous load of apples. Really unbelievable. Without any human attention, nature, assisted by the bees, had just been doing its own thing.

To start things, I planted some sweet corn, some silverbeet and a few parsley seedlings given to me by a friend. I also developed the habit of taking a walk around the garden before going to bed.

The sweet corn was planted late in the season and when it has noticeably grown a bit I praise and encourage it. The warm weather may last just long enough to bring me some corn cobs. Then over to the compost heap. Putting my hand on the top, I feel the reassuring warmth telling me that in this world of uncertainty Nature continues in its mysterious wisdom, no matter what.

Thus it was that one evening, two months ago now, in the dark, I walked into a spider web. That is to say, my face walked into it while the spider must have seen me coming. For there was no trace of 'The Weaver'. Coming back half an hour later to see how things stood, the Weaver was busily restoring its shop front, the work already half completed.

Since then I call on the Weaver every night, a beautiful Garden Orb Spider. Seen from up close, its back is a light sandy brown. Superimposed in black is a motif that looks a bit like the Crown and Anchor of the merchant navy. The first segment of each front leg is a brilliant red. On the underside, the hind legs are set off in alternate short lengths of black and white bands. The outer hind legs are a different length from the other legs, enabling one claw to be above the other as the Weaver descends to the ground. Head down, it rapidly abseils by its own spider line. I assume that those claws, one above the other clasping the thread, keep the strain off the spinnerets while they exude the spider silk during the descent.

Belonging to the sheet web family of spiders, the web is some 30 by 50 centimetres. It is started every night at dusk and is packed up again at early dawn.

Strung out between the ground and overhead twigs, high enough from the ground for me to walk under, it is quite a large and elaborate affair. With guy lines going here and going there to secure it. When you consider that the Weaver's legs easily span 3 to 5 centimetres from claw to claw, it is not surprising that the Weaver can move with the speed of lightning across its scaffold. This was brought home to me when an electronic flash from the camera disturbed the Weaver. It went suddenly into the packing up behaviour which you can observe every morning before dawn. The Weaver moves around the centre a bit, I think undoing key tie points in the web, for it then drops half the web in a flash, gathering the web into what seems an untidy bundle of thread. It then packs up the top half and takes the untidy bundle of fluff with it into the branches.

During wind-still nights the Weaver sits in the centre of the web waiting, quite flat in the web. But when one night a breeze sprang up, the centre of the web was tossed 3 to 4 centimetres backwards and forwards, at times quite forcefully. The Weaver now stood off the web, hanging on in a manner which reminded me of a sail surf-board rider in a storm.

When it was warm and wind-still, the Weaver wove those large nets every night. Abseiling to the ground to set its guy lines, returning to the canopy of leaves by climbing, head up, in a hand over hand manner. However when a large high pressure area developed over the Bight and Adelaide, the anti-clockwise winds brought cold air from the Antarctic and some rain. I noticed that the Weaver then built a very much smaller

web, sheltered to some extent by hanging amongst the canopy of leaves.

I had hoped that the Weaver would find a mate and reproduce, to keep the unwanted bugs down. Well it seems my hopes will be fulfilled. We have passed the autumn equinox and relative calm has returned for a while. While I haven't seen the Weaver again, there are lots of tiny Weavers. With bodies the size of grains of barley, they make just like Mammie did. Playing at abseiling, hanging around in very small bits of web hung up between the leaves. And like Mammie, you don't see hide nor hair of them during the day. A new cycle has started, a new generation is taking over. That is how life is.

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Defending the Little Desert: the Rise of Ecological Consciousness in Australia

by Libby Robin

Publisher: *Melbourne University Press, 1998. 203 pp., paperback. RRP $24.95.*

The controversy that developed around the Victorian government proposals to subdivide and clear the Little Desert for agriculture in the late 1960s has entered folklore as a turning point in conservation in Australia. The anti-development campaign is important in that it prevented the destruction of an area of extraordinary natural riches. However, the campaign's role in developing the ecological consciousness of the 1970s, and beyond, is seen by many as even more important. Out of this controversy grew the 'balanced' approach to land development and reservation that characterised the subsequent 15 years or so – particularly through the Land Conservation Council of Victoria; but also in national issues such as the Lower Gordon in Tasmania, Fraser Island in Queensland and Kakadu in the Northern Territory. The 'Little Desert Controversy' is important in itself. It is also important because of the accretion of historical perceptions and retrospective assessments of those exciting times.

This new account grew out of a postgraduate project, but the book's style is certainly not that of a dry academic thesis. It is decidedly readable. The book is divided into chapters based on the Little Desert issue itself and the various protagonists, and attempts to place the people and events in the wider social context. The book opens by presenting a simple history of the development of the region and the dispute, wisely avoiding an account of the natural history of the area. After all, many other references have covered these values and, for many of us, they are best 'discovered' directly and personally. Subsequent chapters deal with the campaign from the perspectives of the Victorian National Parks Association, 'ecologists', the locals in the Wimmera and the bureaucrats from Melbourne. The political perspective is not presented in depth, but I suspect that this is no intentional oversight by the author. Verbatim records of cabinet meetings and other political discussions are still not available. Politicians are renowned for responding to the questions they would like to have been asked, rather than the questions they were asked.

The book is obviously the result of meticulous research, all of which is thoroughly referenced. Robin has had access to many sources. At times this has led to notably different styles in the various chapters. The points of view of the main public conservationists are engagingly and personally presented. By contrast, the

chapter dealing with the contributions from public servants is clearly based on voluminous records from public service archives and less so on personal interviews. Nevertheless, Robin astutely realised that such contributions, although less visible, were no less important, and perceptively presents this critical input. The aboriginal material is least satisfactorily treated, either from a current or an historical context. However, I suspect that this is a 'fact of life' for historians dealing with a non-literate culture and a dispersed and substantially dispossessed remnant.

We are offered some insights into the way the central characters approached their various roles in the unfolding drama. Personal aggrandisement seems to have driven no-one, except perhaps the politicians. Ego played only a small part and grandstanding was used to further a public cause, rather than personal profiles. Unlike more recent controversies, the 'conflict' was relatively respectful – at least in public. In some respects, times have changed. In other respects, very little has changed, as those with a longer perspective than the next election were painted as naive and out of touch with 'modern economic realities'.

After the specifics of the Little Desert Controversy have been presented and tied together as a coherent story, Robin attempts (a little less successfully) to put the implications of this history and its perceptions into a wider and current social context. There is a tendency to categorise and classify people and points of view, occasionally losing sight of the distinctiveness of individuals and their particular personalities. But as with all good historical accounts, by the final few sentences, readers will find themselves drawing further lessons and conclusions pertinent to current issues, beyond the Little Desert itself.

My most significant reservation about the book is its approach of seeing 'history' as an unfolding of events with a certain inevitability about them, given a particular social context. As Robert Ingpen has argued elsewhere (1980, *Turning Points in the Making of Australia*, Rigby: Melbourne), history is a weaving together of chance and contrivance, of planning and happenstance. As with other turning points, the 'Little Desert Controversy' is also a mixture of the inevitable with the purely fortuitous. Idiosyncrasies did matter and were important in the unfolding of events. Robin seems to have emphasised the social streaming of events and downplayed the input of chance. Nevertheless, this reservation may be saying as much about the prejudices of this reviewer as it says about the book itself.

The book is very readable. It is an interesting and informative history of the development of environmental consciousness in Australia. It is an insight into people and social attitudes, not too far removed in time. It resonates with contemporary issues, such as alienation of the public estate for private profit and publicly-subsidised native forest destruction for wood chip export. Perhaps it is true that 'the only lesson of history is that we do not learn anything from history'. I hope not …

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From the Editor

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Sue Briggs	Roger Kirkwood	Melody Serena
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Arthur Farnworth	Ian Mansergh	

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David Cheal	Ron Fletcher	Barbara Sharp
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Cover: The Heath Mouse *Pseudomys shortridgei*, photographed at Pomonal in the Grampians by John Seebeck. See Research Report on p. 196.

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Is the Home Range of the Heath Mouse *Pseudomys shortridgei* an Anomaly in the *Pseudomys* Genus?

Edward P. Meulman[1] and Nicholas I. Klomp[1,2]

Abstract
The home ranges of Heath Mice in three different areas of the Grampians National Park, Victoria, were determined by radio-tracking and trapping. Eight individuals were radio-tracked over 11 days in February-March 1996, revealing a mean home range, using the Minimum Convex Polygon method, of 5.65 ha (se = 1.72 ha). This was significantly larger than the mean home range revealed by trapping on three grids of 91-100 folding aluminium traps during 1995-1997 (0.74 ± 0.47 ha, n = 57 animals). There were no significant differences between the mean home ranges of males and females, nor among the three different areas, despite differences in floristics and time since fire. The home ranges recorded in this study are significantly larger than those predicted from allometric equations based on the size of the Heath Mouse (70 g) of 0.07-0.18 ha. Although this anomaly has been recorded in other *Pseudomys* species, it is yet to be explained adequately. (*The Victorian Naturalist* **116** (6), 1999, 196-201.)

Introduction

The area used by an animal for its home range is likely to be the minimum necessary to provide the key resources required, with the actual shape of the home range being determined by the nature and distribution of these resources. Among adult mammals, a primary determinant of home range size is access to food (Hansson 1979; Hixon 1980). Therefore, it is not surprising to find that among different species of mammals there is a clear relationship between home range size and body weight (McNab 1963; Turner *et al.* 1969; Harestad and Bunnell 1979), and between home range and metabolic rate (Mace *et al.* 1983; McNab 1988). Given such relationships, one might predict that populations of the same species, living in habitats of differing productivity, would occupy ranges of correspondingly different sizes.

Studies of the home ranges of many animals are inherently difficult, particularly for the more cryptic and nocturnal small mammals. Before the development of miniature radio-tracking packages, most home range studies of small mammals were based on live-trapping and mark-recapture techniques (e.g. Broughton and Dickman 1991; Stoddart and Challis 1991). The data obtained from trapping grids can be used to provide an estimate of the home ranges of animals within the population if the trapping areas are greater than the home ranges of the animals, and if there are an adequate number of captures of individuals (Stoddart and Challis 1991). Eight to ten repeat captures are considered the minimum required to estimate home range size with reasonable accuracy (Hawes 1977, Montgomery 1979, Desy *et al.* 1989).

Still, there are often significant differences between the sizes of trap-revealed home ranges and estimates obtained using radio-tracking (Jones and Sherman 1983; Attuquayefio *et al.* 1986; Desy *et al.* 1989). Bubela *et al.* (1991) reported that trapping underestimated the home range of the Broad-toothed Rat *Mastacomys fuscus* by as much as 40-60%. Further, resources are not evenly distributed over the home range of an animal; rather, certain areas will be rich in resources while other areas are poor. Certain 'core areas' are likely to be used more frequently than other areas and would probably contain the nest site and dependable resources (Desy *et al.* 1989).

Despite these limitations, studies of home range afford a greater understanding of various aspects of a species' biology, such as food requirements, population density, territoriality and competition. Home range size might also reflect mating systems (Gaulin and Fitzgerald 1988). Several studies have recorded disproportionately large home ranges of some species of *Pseudomys*, perhaps reflecting an anomaly in this genus (e.g. Brandle and Moseby 1999). This paper investigates the home range size of the Heath Mouse *Pseudomys*

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shortridgei, as revealed by live-trapping and radio-tracking and considers whether the sizes recorded are an artefact of the methods used to determine home range, an anomaly of this group of mammals and/or a reflection of the biology of the *Pseudomys* species.

Methods

Study area

The Grampians National Park is located in central western Victoria approximately 270 km northwest of Melbourne. Three areas of heathland in the park (locations A, B and C; Fig. 1) were surveyed every 1-2 months over three years (1993-1996). One hundred individual trap sites in a 10 × 10 grid formation (sites 20 m apart) were established at locations A and B, while location C comprised 91 individual trap sites in a 13 × 7 grid configuration. Locations A and B had last been burnt in 1987, giving a seral stage of 7-8 years, while location C was last burnt in 1980 (15 years earlier).

Trapping procedures and data collection

A single folding aluminum Elliott trap was placed at each trap site and baited with a mixture of peanut butter, rolled oats and honey. Each trap was covered with a plastic bag and a liberal amount of clean cotton wool was placed in each trap to provide insulation for captured animals. During hot weather, traps were closed during the day and reset in the evening. Captured Heath Mice were weighed, examined for sex and reproductive condition, given an individual mark (ear-clipping) and released at the point of capture.

Only those animals that were caught ten or more times were used in the analysis of trap-revealed home range. For paired comparisons of home ranges of individuals in breeding and non-breeding seasons (October-February and March-September respectively), only those animals that had been caught five or more times in each season were used in the analyses.

Radio-tracking procedures and data collection

Five male and three female Heath Mice were each radio-tracked for 10-11 days during February-March 1996 at Locations A and B. Each Heath Mouse was fitted with a small radio transmitter attached around the neck (Fig. 2) just behind the mandible and secured using surgical tubing (Meulman and Klomp 1997). Each radio-collar weighed approximately 3.5 g, representing 5-6% of the body weight of the animals. After attachment of the collar, animals were placed in a holding cage (Meulman and Klomp 1996) for five minutes of observation prior to release. Radio-tracking of Heath Mice was conducted using two fixed towers and a null-peak system (after O'Connor *et al.* 1987). The direction of each transmitted signal was recorded simultaneously by each operator, but independently from each tower (after Swihart and Slade 1985), yielding a minimum of 14 and a maximum of 42 recorded locations for each individual Heath Mouse. The operators at each tower synchronized their hourly readings during the tracking period, although successive fixes of a given animal (i.e. successful triangulation) were often several hours apart. Previous studies have shown this species to be largely nocturnal, although data were collected over 24-hour periods on a number of occasions.

The accuracy of bearings taken from the two fixed towers and the accuracy of determined signal directions were validated using radio transmitters removed from

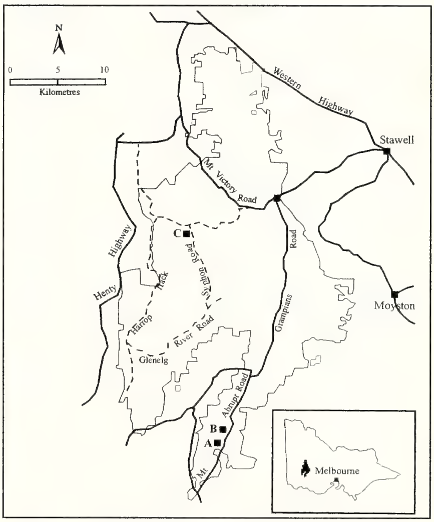

Fig. 1. The Grampians National Park showing trapping and radio-tracking locations (A, B and C) used in this study.

Fig. 2. Heath Mouse fitted with a small radio transmitter. The surgical tubing used to secure the transmitter is clearly visible. Photo by Reeto Zollinger.

individual Heath Mice and a surveyors theodolite (see Meulman and Klomp 1997).

Data analysis

Bearings taken from the two towers were converted to local co-ordinates using *Locate II*, a computer program, and an error ellipse was described around each group of co-ordinates for each Heath Mouse, allowing rejection of any reading having too large an error. Co-ordinates obtained from radio-tracking and trapping were analyzed using another computer program, *Calhome*, to estimate home range using the minimum convex polygon method (MCP). The MCP method determines home range from the convex polygon formed by joining the most peripheral points (fixes) with straight lines (Mohr 1947, Trevor-Deutsch and Hackett 1980). Core areas were defined as the area encapsulating 75% of all captures, and were calculated using the harmonic mean (75% isopleth) method. The 75% isopleth was chosen as the core area following Dixon and Chapman (1980), because estimates of home range expand rapidly when the outlying 25% of points are included. All data were checked for normality of distribution (Kolmogrov-Smirnov, all *P*s > 0.2) and homogeneity of variances (Bartlett's test, all *P*s > 0.7) prior to any parametric-tests being used to test the significance of any differences recorded among groups.

Results

Home range revealed by trapping

The mean size of trap-revealed home range of Heath Mice was 0.74 ± s.d. 0.47 ha ($n = 57$). A two-way ANOVA revealed no significant differences between the home range sizes of male and female Heath Mice ($F_{1, 49} = 0.361$, $P = 0.550$), or among the home range sizes of Heath Mice occupying different locations ($F_{3, 49} = 0.969$, $P = 0.415$), and no significant two-way interaction was found between location and sex ($F_{3, 49} = 0.062$, $P = 0.980$).

A two-way ANOVA was used to examine differences between mean home range sizes observed in breeding and non-breeding seasons and different sexes. No significant difference was found between sexes ($F_{1, 22} = 0.272$, $P = 0.607$), nor between seasons ($F_{1, 22} = 0.011$, $P = 0.918$), and no significant two-way interaction was found between sex and season ($F_{1, 22} = 0.026$, $P = 0.958$).

The mean trap-revealed core areas of male Heath Mice (0.31 ± s.d. 0.22 ha, $n = 31$) and those of female Heath Mice (0.27 ± s.d. 0.21 ha, $n = 26$) were not significantly different (Student's $t = 0.591$, d.f. = 55, $P = 0.556$). While MCPs overlapped for some individuals, the core areas of female Heath Mice did not overlap, but rather adjoined along common boundaries. The shape of core areas varied considerably among individual females, depending on the number of intensively used sites within the home range. The core areas of five males overlapped almost completely (90-100%) with female core areas. However, not all male core areas were associated with individual females, but overlapped the core areas of both females and other males.

Home range revealed by radio-tracking

Table 1 presents the home range sizes of the eight Heath Mice radio-tracked in this study. The mean home range size (MCP) determined from radio-tracking (5.65 ± s.d. 4.85 ha) was significantly larger than trap-revealed home range size (Student's $t = 2.897$, d.f. = 66, $P = 0.005$). The mean home range size of radio-tracked male Heath Mice (7.48 ± s.d. 5.18 ha) and that of female Heath Mice (2.60 ± s.d. 2.52 ha) did not differ significantly (Student's $t = 1.492$, d.f. = 6, $P = 0.186$).

Table 1. Home ranges and core areas (in ha) of the adult Heath Mice *Pseudomys shortridgei* radio-tracked in this study. Areas were estimated using the harmonic mean method (Dixon and Chapman 1980), and minimum convex polygon (MCP) (Mohr 1947). n = number of fixes per animal.

Sex	Weight (g)	n	Core area size	Home range size (harmonic mean)	Home range size (MCP)
F	62	19	0.005	0.26	0.37
F	68	37	0.590	3.99	5.34
F	63	20	0.290	5.90	2.09
M	64	32	0.327	4.01	5.67
M	60	41	0.328	3.09	4.95
M	65	35	0.433	8.32	11.60
M	68	42	0.827	2.84	13.94
M	70	14	0.018	0.68	1.23
Mean	**65.0**	**30.0**	**0.35**	**3.64**	**5.65**
se	**1.21**		**0.10**	**0.93**	**1.72**

Discussion

The mean weight-loss incurred by animals wearing radio-collars was 5.0 g (± 3.2 g), approximately 7% of body weight. No animals were injured as a result of the radio-collar attachment. The minimum convex polygon method was used for home range analyses in this study because it is the only technique that is strictly comparable between studies, and is more robust than other techniques when the number of locations is low (Harris *et al.* 1990). Many authors have reported sex-related differences in home ranges of rodents, with larger home ranges occupied by males, particularly during the breeding period (Mineau and Madison 1977; Wolton 1985; Attuquayefio *et al.* 1986). Gaulin and Fitzgerald (1988) suggested that home range size might be a predictor of mating systems. In rodent populations characterised by a promiscuous mating system, males have larger home ranges than females because of the intense male to male competition for mates. In contrast, monogamous rodent species would have home range areas that are similar for both sexes (Swihart and Slade 1989), with breeding pairs normally sharing a home range that they defend against same-sexed conspecifics (Kleiman 1977). Home ranges of Heath Mice examined in this study were found to be similar for both sexes. Although the sample size of radio-tracked animals is too small to be confident of this result, the total number of trapped animals from which trap-revealed home range sizes were calculated (n = 57) is comparatively large, and strongly supports this conclusion. This result is also consistent with Happold's (1976) suggestion that Heath Mice are largely monogamous, so would be expected to have similar home ranges.

Variations in the size of home ranges of mammals have been associated with social factors, such as access to females (Bubela and Happold 1993), metabolic requirements (Mace *et al.* 1983) and dispersion of resources (Montgomery *et al.* 1991). Comparative studies of mammals have repeatedly indicated that home range size correlates positively to body size (McNab 1963; Harestad and Bunnell 1979; Lindstedt *et al.* 1986; Reiss 1988; Swihart *et al.* 1988; du Toit 1990; Gompper and Gittleman 1992). A number of allometric equations have been developed to predict the size of an animal's home range based on its body mass. These are all modifications on McNab's (1963) original hypotheses, and all depend on the basic assumption that home range size varies as a function of metabolic requirements. Simply stated, larger mammals have larger home ranges because they need more energy resources. While density of food is considered an important factor, Harestad and Bunnell (1979) found that body-weight accounted for 75-90% of the variation in mammalian home ranges. Using a mean body weight of 70 g for Heath Mice (Cockburn 1979), the allometric model of Harestad and Bunnell (1979) relating home range to body mass of herbivorous mammals ($H = 2.71M^{1.02}$, where H is the home range in hectares and M is body mass in kg) predicts a home range of 0.180 ha for Heath Mice. The predicted home range

based on the equation $H = 4.90M^{1.56}$ as proposed by Swihart *et al.* (1988) calculates a home range area of 0.07 ha.

These predicted home ranges are significantly smaller than the mean home range (MCP) of Heath Mice calculated from trapping data (0.74 ha) and from radio-tracking data (5.65 ha). The core home ranges of 0.27 ha for females and 0.31 ha for males determined in this study are still 1.5 times larger than those predicted by either equation. These calculations of core home range are based on trapping data, which underestimate actual home range area (Bubela and Happold 1993). Hence it is clear that the home range of the Heath Mouse does not fit either of the proposed allometric equations relating home range to body mass.

Other Pseudomys *species*

While there is only limited published information available on the home range of the *Pseudomys* species, the Heath Mouse appears not to be alone within the genus in having a disproportionately large home range. Anstee *et al.* (1997) reported that radio-tracking revealed a home range of up to 14.4 ha for the Pebble-mound Mouse *Pseudomys chapmani* (12-15 g), with core areas also being very large. Radio-tracking studies of the Shark Bay Mouse *Pseudomys fieldi* have revealed that this species also has a large home range of between 3-4 ha (Speldwinde *pers. comm.*). The New Holland Mouse *Pseudomys novaehollandiae* (20-25 g) was found to have a home range (MCP) of 0.84 ha for males and 0.51 ha for females (Lock 1995). Again, this is much larger than would be predicted from body size alone, despite this latter study using trapping to determine home range – a technique that usually underestimates the home range of small mammals (Bubela *et al.* 1991).

However, not all *Pseudomys* species have disproportionately large home ranges. Stoddart and Challis (1991) estimated the mean home range of the Long-tailed Mouse *Pseudomys higginsi* as 0.20-0.26 ha, using the inclusive boundary strip method. This method estimates home range in a similar way to the MCP method, but includes the addition of a peripheral boundary strip around the polygon, the width of which is equivalent to half the inter-trap distance (Trevor-Deutsch and Hackett 1980). Although the Long-tailed Mouse is of similar size and weight to the Heath Mouse, its estimated home range is closer to that predicted by the standard allometric equations. Given the different methods used, further investigation of the home range of the Long-tailed Mouse would be useful.

One explanation of the apparent variation in home range sizes used by different species of *Pseudomys* may be that the recorded differences are not species specific, but rather simply reflect habitat quality in a given area. For example, the home range of the Plains Rat *Pseudomys australis* appears to vary with habitat quality (Brandle and Moseby 1999). In areas containing high quality habitat, females occupied home range areas of around one hectare, while those of males were around 4-5 ha (Brandle *pers comm.*). In poor quality habitat, female home range areas were seen to increase to 8 ha. As this species weighs between 40-45 g, its home range is considerably larger than would be predicted by any of the allometric equations.

However, this study found no differences in size of home ranges of Heath Mice in different areas, despite variation in time since last fire and floristics between the study sites, which presumably reflected variation in habitat quality. Clearly, more detailed studies of the home range of *Pseudomys* species are required to determine the reasons for their apparently large home ranges, and how biotic and abiotic factors may influence and reflect home range.

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Germination and Sowing Depth of Wallaby Grass *Austrodanthonia eriantha*: Techniques to Maximise Restoration Efforts

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Abstract

Knowing the germination requirements of a particular population of plants is essential in the process of habitat restoration, so that germination and establishment in the field is maximised. This study investigated the temperature required for germination, the sowing depth for maximum emergence and the effects of treatments in overcoming dormancy in a population of Wallaby Grass *Austrodanthonia eriantha* from Mount Piper, Broadford, Victoria, the habitat of the endangered Golden Sun Moth *Synemon plana*. The temperature required for maximum germination was 15°C. Removing the palea and lemma from freshly-harvested seeds or storing seeds for two years at room temperature resulted in a twenty-fold increase in germination. Treatment with sulphuric acid (chemical scarification) increased germination from 4% to 56%, whilst soaking in potassium nitrate and stratification for 50 days or 100 days had no significant effect on germination. Burial at a depth of 20 mm or greater had a pronounced inhibitory effect on the emergence of seeds of *A. eriantha*. Therefore these results suggest that establishing *A. eriantha* at Mount Piper would best be achieved by sowing caryopsides in autumn when air temperatures average 15°C and water is not limiting. Caryopsides should be collected in December, stored for approximately 4 to 5 months and sown directly on the surface of the soil. Further field trials are required to test these suggestions. (*The Victorian Naturalist* **116** (6), 1999, 202-209.)

Introduction

Plants in the genus *Austrodanthonia* (family Poaceae), previously *Danthonia* (Linder 1997), are commonly known as Wallaby Grasses and are a common feature of open forests, woodlands and grasslands. Native grasslands are one of the most endangered vegetation types in Australia (Groves 1979; McDougall and Kirkpatrick 1994) and those that are dominated by *Austrodanthonia* spp. are becoming increasingly rare. These particular grassland types provide habitat for the endangered Golden Sun Moth *Synemon plana* (Figs 1 and 2). Once widespread throughout southeastern Australia, the Golden Sun Moth is now known from only four sites in Victoria, 12 sites in the Australian Capital Territory and 15 sites in New South Wales (Clarke and O'Dwyer 1997). The population of Golden Sun Moths found at Mount Piper, 80 km north of Melbourne, inhabits a native grassland dominated by Wallaby Grass *A. eriantha* Linder, H.P. (Lindl. in T. Mitch.) (O'Dwyer and Attiwill 1999).

Knowing the germination requirements of a particular plant population is essential in the process of habitat restoration, so that germination and establishment in the field is maximised. Previous work on the mechanisms of seed germination and the effects of environmental influences on germination to increase crop production has concentrated on economically important species for agriculture, forestry and horticulture (e.g. *Pisum sativum*, Eeuwens and Schwabe 1975; *Phaseolus vulgaris*, Van Onckelen *et al.* 1980; *Lupinus albus*, Davey and Van Staden 1979; *Hordeum vulgare*, Collins and Wilson 1975; *Acer saccharum*, Webb *et al.* 1973; *Pinus radiata*, Donald and Jacobs 1990; *Audouinia capitata*, de Lange and Boucher 1990; *Anigozanthos manglesii*, Sukhvibul and Considine 1994; see Appendix for common names). However, Australian native species are now receiving considerably more attention as conservation and restoration efforts are increasing (Morgan and Myers 1989; Myers and Morgan 1989; Sindel *et al.* 1993; Baxter *et al.* 1994).

There has been little work on the germination requirements of *Austrodanthonia* spp. (Toole 1939; Laude 1949; Lindauer 1972; Hagon 1976; Lodge and Whalley 1981; Lodge 1993; Lodge and Schipp 1993a, b). However, these investigations revealed that different *Austrodanthonia* spp., and different populations, differed in

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Fig. 1. Female Golden Sun Moth *Synemon plana*. Photo by E.D. Edwards, CSIRO.

Fig. 2. Male Golden Sun Moth *Synemon plana*. Photo by G. Clarke, CSIRO.

their germination requirements. For example, seeds of *A. caespitosa* (as *Danthonia caespitosa*) collected from areas in higher latitudes germinated at higher temperatures than those collected from lower latitudes (Hodgkinson and Quinn 1976). Trumble (cited in Cashmore 1932) found that *Austrodanthonia* (as *Danthonia*) seeds germinated at 18-20°C, whilst both Maze *et al.* (1993) and Lodge and Whalley (1981) found that *A. caespitosa* (as *Danthonia caespitosa*) germinated over a range of temperatures and concluded that *Austrodanthonia* was not significantly affected by temperature. This variability is also common in other grass species (Hagon 1976; Mott 1978; Sawhney and Naylor 1979; Groves *et al.* 1982). Temperature, moisture and seed dormancy affect the germination and establishment of native grasses (Hagon 1976).

No published information has been found on the germination requirements of *A. eriantha*. This study investigated the temperature required for maximum germination, the sowing depth for maximum emergence and the effects of treatments in overcoming dormancy in a population of *A. eriantha* from Mount Piper, Broadford, Victoria. The results will be used to attempt to maximise germination of *A. eriantha* in the field at Mount Piper.

Methods

Fully mature dispersal units (caryopsides; the seed together with the surrounding palea and lemma) of *Austrodanthonia eriantha* were collected from Mount Piper, Broadford in December 1995. Germination tests began soon after harvest. Air-dry, non-dormant caryopsides were collected from Mount Piper in 1993 and stored in paper bags in the dark for two years at 25°C. Prior to treatment, caryopsides were dusted with fungicide (Thirum).

Laboratory germination at constant temperatures

To examine the effects of temperature on germination, seeds were germinated in chambers at constant temperatures of 8°, 15°, 20°, 26°, and 32°C. The germination of caryopsides that were freshly harvested, dry-stored for 2 years, or cold-treated (method described below under Dormancy), were compared for each of the temperature regimes. Experiments ran for 30 days and under favourable conditions, all viable seeds germinated within 7 days of imbibition.

In each treatment, five replicates of 20 caryopsides were placed in 9 cm sterile petri dishes with 5 ml of distilled water, on top of two layers of Whatman filter paper, No. 41. Petri dishes were sealed using clinical test-ware tape. Light intensity of 300 lux was supplied by Philips warm-white fluorescent tubes, set for a 12 hour photoperiod. A seed was considered to have germinated when the radical reached 1 mm in length.

The viability of each seed lot was determined by dissection of all the un-germinated seeds at the completion of the germination test. Seeds were classified as viable if the embryo and endosperm were still firm and intact, or as dead if the seeds had turned pulpy and begun to decay. Germination was expressed as the percentage of viable seed.

Dormancy

Freshly-harvested caryopsides of *A. eriantha* were treated in a variety of ways in an attempt to break dormancy. The treatments were (a) cold stratification, (b) removal of palea and lemma, (c) dry storage, (d) soaking in potassium nitrate KNO_3, and (e) soaking in sulphuric acid H_2SO_4. For cold stratification caryopsides were placed in 9 cm petri dishes, with 5 ml of distilled water. The petri dishes were sealed with clinical test-ware tape and placed in a refrigerator at 5°C for 50 days and 100 days. For the KNO_3 treatment, caryopsides were soaked in 20 ml of 0.8% (w/v) of KNO_3 at room temperature for 24 hours and rinsed once with distilled water. Treatment with H_2SO_4 (chemical scarification) involved soaking caryopsides in 20 ml of 50% (v/v) of H_2SO_4 at room temperature for 25 minutes. Caryopsides were washed thoroughly for 10 minutes with distilled water.

Both untreated and treated caryopsides were placed in petri dishes and incubated in a controlled temperature incubator at 15°C, which was found in the first experiment to be optimal for the germination of *A. eriantha*. All other conditions were as described for the previous experiment. Only healthy, well-developed seeds were selected based on the results of viability developed in the preceding experiment.

Emergence from varying depths

Caryopsides of *A. eriantha* that had been kept in dry-storage for 2 years were sown at four depths (0 mm, 5 mm, 10 mm, 20 mm) in a commercial grade potting mix and in soil collected from the field site at Mount Piper. The soil was surface-sterilised and soaked with water for two days prior to sowing. Two wooden seedling boxes (500 × 500 × 70 mm) were filled, one with field soil and the other with the potting mix. To prevent compaction in the box, soil collected from Mount Piper was mixed with commercial mineral sand in a 1:1 ratio prior to sterilisation. There were four replicates of each treatment in each seedling box, with each treatment in a different row and column set out in a latin square design. Twenty-five caryopsides were sown, approximately 10 mm apart at each depth. A buffer-zone of 20 mm was left between each treatment. Caryopsides were placed on the surface of the soil (0 mm) or at depth using a ruler to create a furrow. Seeds were kept in a glasshouse at 23°C with natural lighting and watered when required. The experiment ran for 60 days. Only healthy, well-developed seeds were used in these trials.

Data analysis

All data sets were tested for normality and homogeneity of variance and were log transformed if required. A t-test was used to compare means. A two-factor repeated measure ANOVA was calculated on the transformed data, which was then back-transformed for data presentation.

Results

Temperature

The percentage germination (after 30 days) of viable dry stored seeds of *Austrodanthonia eriantha* (86%) was greatest at 15°C (Fig. 3). The decrease in germination of dry stored seeds at each temperature above and below 15°C was significant ($p < 0.05$). Seeds did not germinate at 32°C, for any treatment. Only a small percentage of fresh seed (17%) and cold stratified seed for 50 days (13%) germinated at 15°C. Viability was 50%.

Dormancy

Germination of *A. eriantha* increased twenty-fold after storage ($p < 0.05$; Fig. 4). Similarly removing the palea and lemma from freshly-harvested seeds also resulted in a twenty-fold increase in germination ($p < 0.05$; Fig. 4). Treatment with H_2SO_4 (chemical scarification) increased germination from 4% to 56% (Fig. 4). However, this was significantly less than increases due to air-dry storage or glume removal. Soaking in KNO_3 and stratification for 50 days or 100 days had no significant effect on germination relative to the control ($p > 0.05$; Fig. 4).

Emergence from varying depths

Seeds of *A. eriantha* germinated and emerged at all depths but there was a significant reduction in emergence when seeds were sown at 20 mm ($p < 0.05$; Fig. 5). There was no significant difference between the emergence of seeds sown at 0 mm, 5 mm, and 10 mm on either of the soils. Emergence was greatest when seeds were sown at 0 mm (38%).

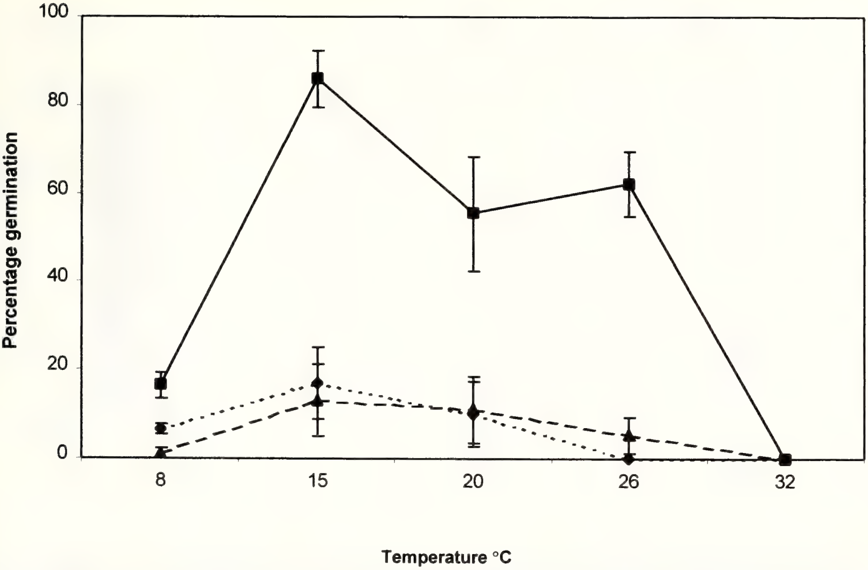

Fig. 3. Effect of temperature on germination of *Austrodanthonia eriantha*, immediately after dispersal (◆, dotted line), after air dry storage for two years (■, solid line), and after cold stratification of fresh seed for 50 days (▲, dashed line). Percentage germination was determined from 5 replicates of 20 dispersal units after 30 days. (Intermediate temperatures were not tested.) Error bars show the standard error of the mean.

Discussion

Maximum germination of *Austrodanthonia eriantha* was at 15°C (Fig. 3), and at Mount Piper this would be met in late autumn or early spring, when the air temperature averages 15°C. This supports the work by Lodge (1981) and Hagon (1976) who found that *Austrodanthonia* species and other cool-season grasses germinated from mid autumn to late winter. Lack of germination at 32°C (Fig. 3) suggests that high air temperatures in summer may restrict the germination of *A. eriantha*.

Inflorescences of *A. eriantha* are produced in December and most of the seeds are dormant at the time of dehiscence (seed release). Dormancy is overcome by a time lag (Fig. 4) after dehiscence, during which seeds after-ripen. The loss of dormancy with time has been attributed to an increase in biosynthesis of gibberellins in the caryopsis or a loss of inhibitors from the palea and lemma (Hagon 1976). In this study the exact nature of the physiological role of the lemma and palea in dormancy was not investigated. However, previous experiments have shown that these structures may contain inhibitors (Bradbeer 1988), may mechanically restrict the protrusion of the radicle (Ikuma and Thimann 1963), may reduce oxygen to the embryo (Roberts and Smith 1977), or may prevent the leaching of inhibitors, thus preventing germination (Webb and Wareing 1972).

The germination of dormant *A. eriantha* seeds increased after the removal of the palea and lemma (Fig. 4), ruling out the possibility that embryo dormancy has a major role in inhibiting germination, although embryo dormancy has been observed in other *Austrodanthonia* species. Lodge and Whalley (1981) showed that by removing the palea and lemma from *Austrodanthonia linkii* (as *Danthonia linkii*), germination did not increase and Laude (1949) found that hulling *A. california* (as *D. californía*) only marginally increased germination. The lack of response to germination by chilling and soaking in KNO_3 (Fig. 4) also provides evidence for coat induced dormancy as both of these treatments involve conditions inside the embryo. Toole (1939) found that *A. spicata* (as *D. spicata*) germination

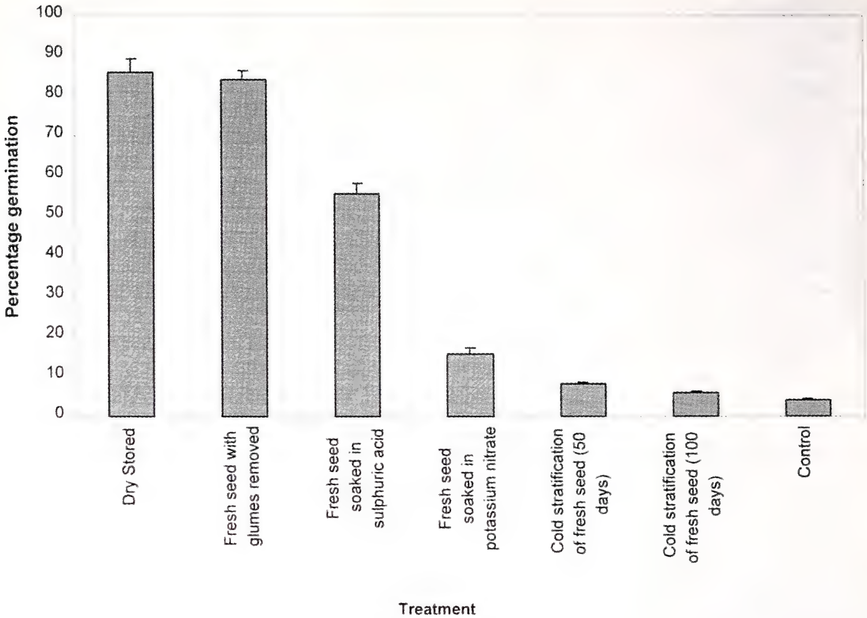

Fig. 4. Effects of different storage and dormancy breaking treatments on the germination of *Austrodanthonia eriantha* seeds. Percentage germination was determined from 5 replicates of 20 caryopsides after 15 days at 15°C. (Fresh seed was soaked in 50% H_2SO_4 and 0.8% KNO_3.) Error bars show the standard error of the mean.

increased after chilling at 3°C for 63 days, and also responded to the addition of 0.2% KNO_3. However, Toole (1939) concluded that dormancy was coat-induced as, at the time of publication, the effects of KNO_3 and cold stratification were unknown. It can be concluded that the dormancy of *A. eriantha* from Mount Piper is coat-induced, imposed by the palea and lemma.

Chemical scarification did not result in complete germination (Fig. 4) and this may be due to the incomplete digestion of the palea and lemma; i.e. remnants may have had an inhibitory effect. Morgan and Myers (1989) found that germination of dormant *Diplachne fusca* seeds decreased when treated with a solution derived from macerated lemmas. It is likely that the lemma and palea of *A. eriantha* contain an inhibitor, as chemical scarification would enable gas to be exchanged between the embryo and the external environment, and the radicle to protrude resulting in complete germination.

As previously mentioned the degree of dormancy varies between populations, but it also varies within populations. Laude (1949) found non-dormant seeds of *A. california* (as *Danthonia california*) germinated over a 16-week period illustrating the variability within the population. This was also shown in *A. sericea* (as *D. sericea*; Lindauer 1972). In the present study, the germination of *A. eriantha* was also variable. Some seeds (17%) germinated immediately after dehiscence, indicating that these seeds were non-dormant whilst the majority required an after-ripening period. A small percentage (14 and 16%) of both dry-stored seeds and those with palea and lemmas removed did not germinate. Dormancy in these seeds, which were probably still viable, may be embryo-induced. This variability in dormancy would spread the risk of establishment and ensure that some seeds from the same population persist for several seasons (Lodge and Whalley 1981).

Removing the palea and lemma may not be economically feasible on a large scale and may actually hinder germination in the field. Awns and glumes protect the seed in

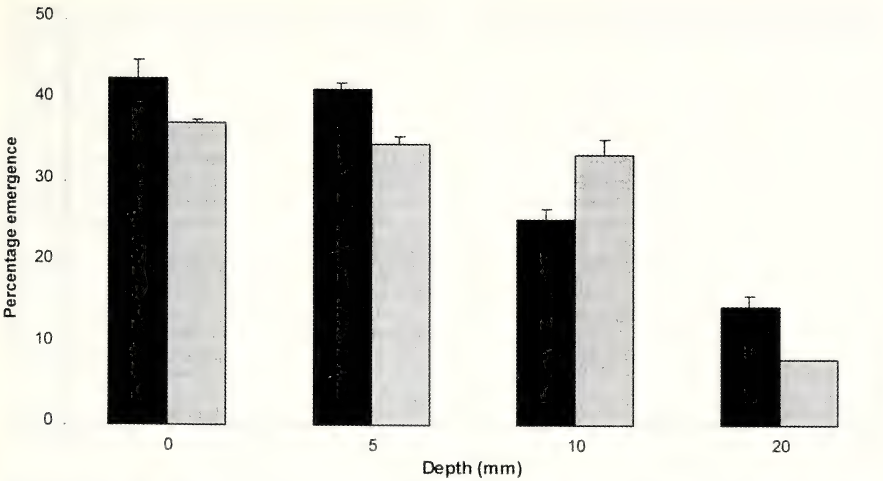

Fig. 5. Effects of different sowing depths on seedling emergence of viable seeds of *Austrodanthonia eriantha*, in a commercial potting mix (solid bars), and in soil collected from Mount Piper, Broadford (shaded bars) Caryopsides were germinated under glasshouse conditions. Percentage emergence was determined from 4 replicates of 25 caryopsides after 30 days. Error bars show the standard error of the mean.

the field, orientate the seed for maximum seed/soil contact and enable the seed to lodge in the most favourable microsite (Peart 1979; Peart 1981; Sindel *et al.* 1993).

Burial at depth of 20 mm or greater has a pronounced inhibitory effect on the establishment of seeds of *A. eriantha* (Fig. 5). The germination of buried seeds may be dependent upon the exposure to light (Wesson and Wareing 1969). At depths greater than 2 mm insufficient light penetrates the soil to induce germination of some seeds (Woolley and Stoller 1978). Since some seeds of *A. eriantha* germinated at depths of 20 mm, it can be concluded that light is not required for germination of all seeds. Work on other *Austrodanthonia* species found that germination of non-dormant units was not restricted by light (Hagon 1976; Maze *et al.* 1993). Wesson and Wareing (1969) showed that by aerating the soil, inhibiting gases are removed allowing germination to proceed. As a light effect is not involved, soil aeration may be an active factor in preventing germination. The present study showed that there was no difference in the emergence of *A. eriantha* in a well-aerated potting mix compared with that of the field soil ($p > 0.05$; Fig. 5) and therefore soil compaction was not involved. It is more likely that the food reserves in the seed are depleted before the seedlings reach the surface and establish.

Further field trials are required, nonetheless these results suggest that establishing *Austrodanthonia eriantha* in the field would best be achieved by sowing caryopsides in autumn, when air temperatures average 15°C and water is not limiting. Caryopsides should be collected in December, stored for approximately 4 to 5 months and sown directly on the surface. The presence of inhibitors in the palea and lemma limits germination immediately after seed fall even though temperature and moisture may be suitable for germination. This prevents the loss of seedlings due to high summer temperatures. A few months after seed fall, the concentration of inhibitors in the palea and lemma, enforcing dormancy would decrease as a result of after-ripening. By this time temperature at Mount Piper would be suitable for the germination of *A. eriantha* (15°C) and seedlings would be expected to establish in the cool autumn conditions and continue growing through winter and spring.

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Glossary

awn – a fine bristle-like appendage, especially occurring on the glumes of grasses.
caryopsides (caryposis) – a dry, indehiscent, one-seeded fruit in which the seed coat is closely fused to the fruit wall, e.g. in most grasses.
dehiscence – to open spontaneously along certain lines or in a definite direction when ripe, as seed capsules.
gibberellins – plant growth substances; can have spectacular effects upon stem elongation in certain plants; can break dormancy in some seeds.
glume – the chaffy lower-most organs of a spikelet, which forms the inflorescence of grasses and similar plants.
inhibitors – a restraining or preventing factor.
lemma – the lower of two bracts enclosing an individual grass flower.
palea – the upper of two bracts enclosing an individual grass flower.
radicle – the part of an embryo giving rise to the shoot system of a plant.

Appendix.

Common names of plants mentioned in the text.

Acer saccharum	Maple
Anigozanthos manglesii	Kangaroo Paw
Audouinia capitata	False Heath
Hordeum vulgare	Barley
Lupinus allus	Lupin
Phaseolus vulgaris	Bean
Pinus radiata	Monterey Pine
Pisum sativum	Pea

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Barbed Wire Fencing as a Hazard for Wildlife

Rodney van der Ree[1]

Abstract
Anecdotal reports from landholders and biologists suggest that the entanglement and subsequent death of animals on barbed wire fences is widespread in Australia. In this report, I collate records of at least 62 species of wildlife that have become entangled on barbed wire fences in Australia. This paper is divided into two components; the first focuses on an area near Euroa in northern Victoria as a case study, and the second lists records from throughout Australia. In the Euroa study area, the species most commonly encountered on fences were gliding marsupials (Sugar Glider *Petaurus breviceps* and Squirrel Glider *P. norfolcensis*) (26 individuals), followed by birds (7 individuals). On a continental scale, species found entangled in barbed wire include gliding marsupials, flying-foxes, aquatic birds, night birds and birds of prey. Records were collected from a wide range of habitats and localities, including the urban-rural fringe, forests and woodlands, agricultural landscapes, semi-arid areas and around water bodies. All individuals were found entangled with barbed wire, and more than 95% of entanglements occurred on standard height farm fencing. Recommendations for alternatives to barbed wire fencing are discussed. (*The Victorian Naturalist* **116** (6), 1999, 210-217.)

Introduction

During a study of the ecology of arboreal marsupials in a network of roadside and streamside vegetation near Euroa, Victoria, a number of Squirrel Glider *Petaurus norfolcensis* and Sugar Glider *P. breviceps* carcasses were discovered suspended from barbed wire fences (Fig. 1). There have been several incidental observations of such deaths for a range of species in Australia and overseas (Russell 1980; Allen and Ramirez 1990; Andrews 1990; Krake 1991; Nero 1993; Land for Wildlife 1994; Platt and Temby 1994; Johnson 1995; Anonymous 1996; Tischendorf and Johnson 1997; van der Ree 1997; Campbell 1998; Johnson and Thiriet 1998) but the extent of this problem is still relatively unknown. The aim of this study was to quantify the extent of the situation by collecting records from a range of sources and describing the actual event (e.g. species, fence type, which strand of wire, location).

Study area and methods

Case study – Euroa, Victoria

The study area lies within the northern plains of Victoria and is bounded by the towns of Euroa, Violet Town, Nagambie, Avenal and Murchison. Formerly dominated by open eucalypt woodland, there is now 3.6% remnant vegetation cover, approximately 85% of which occurs as linear strips along roads and streams (van der Ree, *unpubl. data*). The remaining 15% is made up of small patches of woodland. The major land use is agriculture, with extensive dryland cropping and grazing (Bennett *et al.* 1998).

Observations of animals caught on barbed wire fences were made opportunis-

Fig. 1. Dead Squirrel Glider *Petaurus norfolcensis* caught in a barbed wire fence. Photo by R. van der Ree.

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Table 1. Observations of wildlife entangled with barbed-wire fencing from the Euroa case study area. Species listed in taxonomic order according to Christidis and Boles (1994) (birds) and Menkhorst (1995) (mammals).

Species	Scientific name	Number of individuals	Fence type	Wire type
Mammals				
Squirrel Glider	*Petaurus norfolcensis*	15	f	b
Sugar or Squirrel Glider	*Petaurus* sp.	11	f	b
Birds				
Spoonbill	*Platalea* sp.	1	f	b
Rock Dove	*Columba livia*	1	f	b
Galah	*Eolophus roseicapilla*	1	f	b
Southern Boobook	*Ninox novaeseelandiae*	1	f	b
Australian Magpie	*Gymnorhina tibicen*	2	f	b
White-winged Chough	*Corcorax melanorhamphos*	1	f	b

Fence type: f = standard height farm fence. Wire type: b = barbed wire.

tically while undertaking fieldwork on the ecology of arboreal marsupials. Additional records were obtained from local landholders. There was no systematic searching to detect entangled animals, and consequently the results of this study are likely to underestimate the severity of the problem.

Whenever possible, the following parameters were obtained for each entanglement:

- date found;
- approximate time since death or entanglement;
- species, sex and approximate age (the approximate age of *Petaurus* species was determined using the level of upper incisor wear (refer Suckling 1984; Quin 1995);
- location (latitude and longitude), and description of site;
- the point of entanglement on the animal's body (e.g. wing, neck, tail, gliding membrane);
- the fence characteristics (fence type, barbed or plain wire strand, strand position in the fence).

Australia-wide Perspective

This section is a preliminary report of records from a wide range of people across Australia and is intended to highlight the issue and present initial findings. I collated the same information as that collected for the Euroa study area, from sources including Field Naturalist groups, Landcare groups, landholders and biologists, between 1996 and the present. I also requested records from members of the Ecological Society of Australia, Australasian Wildlife Management Society, Field Naturalist Club of Victoria, and Birds Australia via their electronic mail discussion lists and newsletters. The wildlife atlas data-bases from Victoria and New South Wales were investigated, as was the Wildlife Information and Rescue Service (WIRES) data-base.

Results

Euroa study area

Number and type of species entangled

A total of 33 animals was recorded entangled on barbed wire between 1994 and 1998 in the Euroa study area (Table 1). Fifteen were positively identified as Squirrel Gliders and 11 gliders could not be reliably identified to species and are referred to as *Petaurus* sp. (this group includes only Sugar Gliders and Squirrel Gliders). Other species entangled with barbed wire fencing included the Australian Magpie *Gymnorhina tibicen* (2 individuals) (Fig. 2), and a single Rock

Fig. 2. Ausralian Magpie *Gymnorhina tibicen* caught on barbed wire fence. Photo by R. van der Ree.

Table 2. Point of entanglement of gliders found on barbed wire fences in the Euroa study area, 1994-1998. No. = number of gliders found.

Point of entanglement	No.
Tail only	11
Tail and gliding membrane	4
Gliding membrane and leg	2
Unable to tell (decomposed too far)	3
Not recorded	6
Total found	**26**

Dove (Feral Pigeon) *Columba livia*, Spoonbill *Platalea* species, Southern Boobook *Ninox novaeseelandiae*, White-winged Chough *Corcorax melanorhamphos* and Galah *Eolophus roseicapilla*.

Fence characteristics

All individuals were entangled with barbed wire on standard farm fences approximately one metre high. The apparent point of entanglement of the animal was with the barb on the wire. Where entanglement position was recorded (n=17), 12 entanglements occurred on the top strand of the fence, one occurred on the second strand from the top, and four occurred on the third strand from the top. Once caught on the barbed wire, it appeared that many gliders and birds became further entangled as they struggled to free themselves. On one occasion, the strand of wire was cut and the glider taken, with the wire *in-situ*, to a wildlife shelter for removal and rehabilitation. In the Euroa study area, all 33 records occurred where fences were positioned between cleared paddocks and vegetated roadsides.

Carcass characteristics

The advanced decomposition of many carcasses limited observations on the sex and age of the animals. Four female and one male Squirrel Glider were identified; the sex of 21 gliders and seven birds was not determined. Using the degree of tooth wear on the upper incisors of the gliders as an index of age, four individuals were identified as juvenile and four as adults. Age was not determined for the remaining 18 gliders or seven birds.

For gliders, the most common point of entanglement was the tail (11 records) (Table 2), followed by a combination of the tail and gliding membrane (four records) and the gliding membrane and leg (two records). Three gliders were too decomposed to determine the point of entanglement, and point of entanglement was not recorded for six individuals. Only two gliders were found alive and released, and these were entangled by the tail only. One magpie was entangled by a combination of wing and neck, and the feral pigeon was caught by its leg ring; the point of entanglement was not recorded for the remaining birds.

Australia-wide perspective

Number and type of species entangled

Sixty-two species of wildlife have been observed entangled with barbed wire fencing across Australia (Table 3). The types of species include gliding marsupials, bats, ground-dwelling birds, water birds, night birds and birds of prey. The most numerous group reported entangled with barbed wire fencing were flying foxes from northern Australia. The Little Red Flying-fox *Pteropus scapulatus* appears particularly susceptible to entanglement in north Queensland, with a published report of over 450 individuals entangled in one year (Johnson 1995), and another respondent reported 200 individuals on one fence at the same time (Jon Luly, *pers. comm.*). Many respondents reported observing numerous macropods (Black Wallaby *Wallabia bicolor*, Eastern Grey Kangaroo *Macropus giganteus*, Western Grey Kangaroo *M. fuliginosus*, and Red Kangaroo *M. rufus)* and Emus *Dromaius novaehollandieae* with their legs entangled in the top two strands of fences but could not give detailed information about specific incidents because of the regularity with which they were observed. This problem is not specifically related to barbed wire, as plain wire also entraps kangaroos and Emus by their legs as they attempt to jump the fence, and hence these records have not been included in Table 3.

Mesh fencing may pose a barrier to those species that are too large to pass through the mesh and unable to jump or climb over the fence. Certain species of reptile appear to be particularly susceptible because their rear facing scales and body shape allows them to place their heads through the tightly fitting mesh – but does not allow the rest

Table 3. Observations of wildlife entangled with barbed-wire fencing from across Australia (excluding the Euroa case study records) as reported by volunteer observers. Species listed in taxonomic order according to Christidis and Boles (1994) (birds) and Menkhorst (1995) and Strahan (1983) (mammals).

Species	Scientific name	State (Number of individuals)	Fence type	Wire type
Mammals				
Koala	*Phascolarctos cinerus*	NSW (2), QLD (4)	f	b, m
Greater Glider	*Petauroides volans*	Vic (2), NSW (6), Qld (4)	f	b
Yellow-bellied Glider	*Petaurus australis*	Vic (3), NSW (3), Qld (8)	f	b
Sugar Glider	*Petaurus breviceps*	Vic (25) NSW (9), Qld (44)	f, c	b
Squirrel Glider	*Petaurus norfolcensis*	Vic (24), NSW (12), Qld (5)	f	b
Sugar or Squirrel Glider	*Petaurus sp.*	Vic (12) NSW (1)	f	b
Mahogany Glider	*Petaurus gracilis*	Qld (5)	f	b
Brush-tailed Bettong	*Bettongia penicillata*	Qld (1)	f	b
Tasmanian Pademelon	*Thylogale billardierri*	Tas (1)	f	b
Grey-headed Flying-fox	*Pteropus poliocephalus*	Qld (4), NSW (3)	f, c	b
Little Red Flying-fox	*Pteropus scapulatus*	Qld (666^), NSW (5), NT (6), WA (1)	f, c	b
Black Flying-fox	*Pteropus alecto*	Qld (23), NSW (81), NT (20)	f, c	b
Spectacled Flying-fox	*Pteropus conspicullatus*	Qld (25)	f, c	b
Flying-fox	*Pteropus* sp.	NSW (4), Qld (2), NT (75)	f, c	b
Queensland Tube-nosed Bat	*Nyctimene robinsoni*	Qld (41)	f, c	b
Ghost Bat	*Macroderma gigas*	NT (1)	f	b
White-striped Freetail Bat	*Tadarida australis*	Vic (1)	f	b
Long-eared Bat	*Nyctiphilus* sp.	NSW (1)	f	b
Microchiropteran Bat	species unknown	NSW (1), Qld (2)	f	b
Grassland Melomys	*Melomys burtoni*	NSW (1)	f	b
Red Fox	*Vulpes vulpes*	Vic (1)	f	b
Birds				
Southern Cassowary	*Casuarius casuarius*	Qld (1)	f	b
King Quail	*Coturnix chinensis*	NSW (2)	f	b
Australian Wood Duck	*Chenonetta jubata*	Qld (1)	f	b
Pacific Black Duck	*Anas superciliosa*	NSW (3), Qld (1)	f	b
Hoary-headed Grebe	*Poliocephalus poliocephalus*	Vic (1)	f	b
Short-tailed Shearwater	*Puffinus tenuirostris*	Vic (<5)	f	b
Australian Pelican	*Pelecanus conspicillatus*	Vic (1)	f	b
White-faced Heron	*Egretta novaehollandiae*	Vic (1), NSW (3)	f	b
White-necked (Pacific) Heron	*Ardea pacifica*	Vic (1)	f	b
Nankeen Night Heron	*Nycticorax caledonicus*	NSW (1)	f	b
Royal Spoonbill	*Platalea regia*	Qld (2)	f	b
Wedge-tailed Eagle	*Aquila audax*	Vic (1)	f	b
Brown Falcon	*Falco berigora*	NSW (1)	f	b
Australian Hobby	*Falco longipennis*	NSW (1), Vic (1)	f	b
Peregrine Falcon	*Falco peregrinus*	Vic (1)	f	b
Sarus Crane	*Girus antigone*	Qld (1)	f	b
Buff-banded Rail	*Gallirallus philippensis*	Qld (4)	f	b
Little Button-quail	*Turnix velox*	NSW (2)	f	b
Red-chested Button-quail	*Turnix pyrrhothorax*	NSW (1)	f	b
Lathams Snipe	*Gallinago hardwickii*	NSW (1)	f	b
Bush Stone-curlew	*Burhinus grallarius*	Qld (2)	f	b
Black-fronted Dotterel	*Charadrius melanops*	Vic (1)	f	b
Masked Lapwing	*Vanellus miles*	Vic (1), Qld (1)	f	b
Silver Gull	*Larus novaehollandiae*	Vic (<5)	f	b
Little Corella	*Cacatua sanguinea*	Qld (1)	f	b
Sulphur-crested Cockatoo	*Cacatua galerita*	Qld (1)	f	b
Red-rumped Parrot	*Psephotus haematonotus*	Vic (1)	f	b
Southern Boobook	*Ninox novaeseelandiae*	NSW (1), Qld (1), Vic (3)	f	b
Masked Owl	*Tyto novaehollandiae*	NSW (2)	f	b
Barn Owl	*Tyto alba*	NSW (2), Qld (1), Vic (3)	f	b
Grass Owl	*Tyto capensis*	Qld (1), SA (1)	f	b
Tawny Frogmouth	*Podargus strigoides*	Qld (2), SA (2), Vic (4)	f	b
Australian Owlet-nightjar	*Aegotheles cristatus*	Vic (1)	f	b

Table 3 continued.

Species	Scientific name	State (Number of individuals)	Fence type	Wire type
Laughing Kookaburra	*Dacelo novaeguineae*	NSW (2), Vic (1)	f	b
Dollarbird	*Eurystomus orientalis*	Qld (1)	f	b
Eastern Spinebill	*Acanthorhynchus tenuirostris*	NSW (1)	f	b
Magpie-lark	*Grallina cyanoleuca*	Vic (1)	f	b
Willie Wagtail	*Rhipidura leucophrys*	Qld (1)	f	b
Australian Magpie	*Gymnorhina tibicen*	ACT (1), Qld (2), SA (2), Vic (1)	f, c, na	b
Silvereye	*Zosterops lateralis*	Vic (1)	f	b
Common Starling	*Sturnus vulgaris*	Vic (1)	f	b

^ = Includes records of 200 individuals (Jon Luly *pers. comm.*) and 450 individuals from Ravenshoe district, north Queensland Fence type: f = standard height farm fence, c = 6 to 8 foot cyclone wire mesh fence, na = not assessed Wire type: b = barbed wire, m = mesh.

of their bodies to pass through or retreat. Goats were reported to become entangled with mesh fencing as their horns prevent them from removing their heads from the wire mesh once pushed through. Electrified strands of wire too close to the ground may electrocute Short-beaked Echidnas *Tachyglossus aculeatus* if they attempt to push underneath the wire. Fatal collisions by various bird species with mesh fencing was frequently recorded.

Wildlife also became entangled with wire in non-fence situations; a Kookaburra *Dacelo novaeguineae* was found impaled on a protruding wire on a tree-guard, five White-throated Needletails *Hirundapus Caudacutus* and Black Swans *Cygnus atratus* were observed dead on overhead powerlines and a small insectivorous bat was impaled by a piece of wire on the top of a shed.

Records of fauna entangled with barbed wire were received from across the Australian continent. Wildlife were entangled with barbed wire fences in a wide range of habitats, including arid and semiarid rangelands, temperate woodlands, forests, rainforest, wetlands, urban areas and the rural-urban interface.

Discussion

A localised and widespread problem

The most commonly encountered species entangled with barbed wire in the Euroa area was the Squirrel Glider. In parts of the study area, roadside vegetation supports high densities of the Squirrel Glider and other arboreal marsupials (van der Ree, *unpubl. data*). The total number of Squirrel Gliders that became entangled with barbed wire is probably much greater than that reported here because many carcasses could not be reliably identified. Moreover, this report only includes those individuals that have been found and reported. In Victoria, the Squirrel Glider is present in only a few large reserves (e.g. Chiltern National Park, Killawarra State Park) and is largely restricted to small patches of woodland habitat or linear reserves along roads and streams. This species has undergone a significant decline in abundance and in Victoria is classified as vulnerable to extinction (CNR 1995). The additional threat of mortality from barbed wire fences for small and isolated populations may be detrimental to their long-term persistence.

The records collated from across Australia indicate that the problem is widespread. Records were collected from all states of Australia, with most originating from the eastern mainland states. The absence of records from many areas may be due to a paucity of observers and entanglements going unreported rather than an absence of entanglements. As many entanglements undoubtedly go unobserved and unreported, the results of this study must be considered an underestimation. To realise the full extent of the problem, observations of entanglements need to be reported and systematically collated. Of the data-bases interrogated, only the New South Wales Wildlife Atlas was able to easily retrieve records of wildlife entangled with fences. It would be useful for other data-bases to include a specific code for records that originate from such entan-

glement so that in future the extent of the situation can be accurately described.

Wildlife behavior

In the Euroa area, 85% of remnant vegetation occurs along roads and streams, and the remaining 15% as small patches. The practice of fencing on both sides of roads, streams and around patches places wildlife at risk of encountering a fence. The movement patterns and behaviour of Squirrel Gliders (as revealed by radiotelemetry) in the Euroa area (van der Ree, *unpubl. data*) may increase the risk of becoming entangled with barbed wire fences. Squirrel Gliders, and probably other gliders, risk entanglement with barbed wire fencing when gliding to and from woodland vegetation in paddocks and along roads and streams. Gliders also glide diagonally across corners at 90° intersections to minimise travel distance and energy demands. These behaviours require the glider to regularly cross fencelines. The potential for entanglement also increases as gliding distance increases; the longer the glide, the lower the animal will land on its target tree and the closer it is to the height of the barbed wire fence.

The placement of barbed wire fences in activity paths of other species may also increase the rate of entanglement. In north Queensland, barbed wire fences in fruit bat flight paths regularly cause the entanglement and mortality of at least five species of fruit bat. Removal of bats from barbed wire fences may place humans at risk of infection with bat viruses, and extreme care should be taken when removing these animals[1]. New fencing erected in existing wildlife travel paths can cause the entanglement and death of many individuals. Many respondents reported that kangaroos appear to be highly susceptible to entanglement in new fencing, and that consideration to wildlife movements when designing fences can minimise the problem.

There were insufficient data to determine whether mortality by collision and entanglement with barbed wire is specific to age or sex in any group of species.

[1] Guidelines on how to handle bats are given at the following web address: http://www.bushnet.qld.edu.au/~melissa/ffnff/

Management implications

Habitat restoration and revegetation is a goal of many government agencies, conservation groups and landholders. Fencing is essential to control stock access in order to protect native vegetation and allow for natural regeneration of palatable species. Wildlife populations in many rural areas have already undergone considerable declines, and often exist in small isolated patches of habitat. The loss of individuals by entanglement with fencing is an avoidable and unnecessary additional threat. All fencing that utilises barbed wire to conserve or protect vegetation may conceivably place the fauna using that habitat at risk of local extinction.

High risk areas

It appears from these results that areas of potentially high risk can be identified:

- Highly fragmented areas where animals must regularly cross barbed wire fences to reach different parts of their habitat. This is particularly apparent in the Euroa study area and is probably true for many agricultural areas.
- Regular flight paths for bats and birds, and movement paths for mammals that may include areas of fragmented and continuous habitat.
- Areas with high density populations of species vulnerable to entanglement such as marsupial gliders in the Euroa case study and fruit bats in north Queensland.
- Wetland areas where barbed wire is exposed above the water level.

Fencing alternatives

For an alternative fencing style to be adopted, it must be of equal or greater benefit for stock management. Depending on the farming enterprise, a number of alternatives to barbed wire are available:

- Plain high-tensile fencing wire, if tensioned correctly, can contain most stock. When a fence is being constructed with new materials, consider using multiple strands of high tensile plain wire or plain wire and ringlock mesh (but beware using fine mesh which may also entrap animals or act as a barrier to movement).
- If additional security is required, investigate the option of electric fencing instead of barbed wire. However, beware of the potential risk of electrocution of wildlife.

- If using existing fenceposts, consider removing the existing strands of barbed wire and replacing them with plain wire. In addition, consider adding an electrified strand to the fence for increased security.
- If a plain wire or ringlock mesh option does not offer sufficient security, an electrified strand is not feasible, and the use of barbed wire can not be avoided, then consider avoiding barbed wire on the top two or three strands of the fence – this will reduce, but not eliminate the risk. In high-risk areas, use plain wire or sheath the barbed wire inside poly-pipe to protect animals from the barbs.
- Design the fence to avoid right angles where marsupial gliders may cross diagonally across the corner (Fig. 3), such as at the intersection of two road reserves. This would benefit other wildlife by creating extra habitat as well as reducing fencing costs.

Future investigation should consider:
- Documenting the extent of the problem more fully by government agencies and wildlife rehabilitation organisations through wildlife databases by specifically including 'entanglement with barbed wire' as the cause of death.
- Investigating alternative fence designs that contain stock, are cost-effective to erect and maintain, and do not pose a threat to wildlife.
- Education programs to ensure land managers are aware of the potential risk to wildlife and are able to identify high risk areas or 'hot spots'.

Government agencies and other bodies providing funds for fencing and revegetation projects should consider these findings and encourage the use of non-barbed wire alternatives as a condition for receiving funding. This will reduce the amount of barbed wire fencing being erected, and as old fences are gradually replaced with non-barbed wire alternatives, the loss of fauna to barbed wire fencing will be greatly reduced.

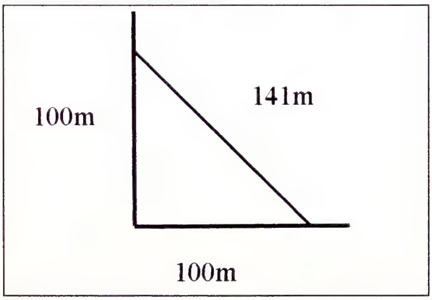

Fig. 3. Fencing diagonally at a 90° corner reduces the amount of fencing materials required, provides additional habitat for wildlife, and potentially minimises the risk of entanglement by wildlife.

Acknowledgements

This is a contribution from the Landscape Ecology Research Group, Deakin University. The financial support of the Holsworth Wildlife Research Fund is gratefully acknowledged. I thank the 120 plus people who provided me with their observations on wildlife mortality associated with fencing and for discussions about fencing requirements. Thanks also to the landholders and residents of the Euroa district who initially alerted me to the problem and gave generously of their time and local knowledge. I thank Andrew Bennett, Jenny Wilson and Sally Kimber and an anonymous reviewer for comments on the manuscript.

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One Hundred Years Ago

THE BLACKFISH – Some interesting notes on the habits of the Blackfish, *Gadopsis gracilis*, McCoy, appear in the *Australasian* of 25th November, which, though written from an angling point of view, are worthy of attention, and possibly criticism, especially by country naturalists. Blackfish can almost be claimed as purely Victorian fish, and even here are nearly confined to the southern streams. The only other habitat of the genus is Northern Tasmania. Professor McCoy recognizes three species, and remarks, in "The Prodromus of Victorian Zoology", vol. i., p.39, that the colour is very variable.

Large Blackfish are undoubtedly scarce, owing to the many enemies they now have to encounter, and are only to be found in the upper reaches of the streams in the most unfrequented portions of the colony. In the early days of Melbourne fish of 6 lbs. to 8 lbs. in weight were of common occurrence, but one hears of such fish but seldom now. One was taken in the Cockatoo Creek, near Seville, in January last, which weighed 7¼ lbs., and it is on record that some twenty years ago a fish was caught in the Ringarooma River, Tasmania, which turned the scale at 13 lbs. 4 oz. In seeking for Blackfish the size of the stream does not seem to matter; in fact, fine fish are often obtained in the smallest streams. They are very shy fish in daylight, seeking the shelter of sunken logs, stones, &c., and though with great care they may be caught in the daytime, especially if the water be discoloured by rain, the best time to secure them is in the brief period between sunset and darkness. They can sometimes be taken all night, but another good time is at just before or at daybreak. The writer, though in favour of protection for the Blackfish, states that the present close season, from 31st August to 15th December, is of no practical use, as in the first place it is rarely observed, and secondly his experience leads him to believe that Blackfish spawn nearly all the year round, as he has taken the fish containing spawn in January, February, March, and April. He suggest that instead of a close season a minimum weight of half a pound should be adopted, and so give the small fish a chance to grow and provide sport worthy of the fisherman.

From *The Victorian Naturalist* **XVI**, p. 130-131, December 1899.

New Assistant Editor

I am pleased to welcome Alistair Evans as Assistant Editor for *The Victorian Naturalist*. Alistair has worked on the journal every week for almost three years as a desk-top publisher, preparing articles for the printer. He has also been a regular proof-reader during this time.

Alistair is a PhD student at Monash University, where his field of research is the functional morphology of teeth and cranial features in microchiropteran bats.

I am looking forward to working with Alistair on your journal, where his expertise in computing, desk-top publishing and statistics will be welcome.

Merilyn Grey

Recent Foraminifera and Ostracoda from Erith Island, Bass Strait

K.N. Bell[1] and J.V. Neil[2]

Abstract
The foraminiferal and ostracodal faunas from a sample at 15 m depth at Erith Island, Bass Strait, are described. The foraminiferal fauna consisted of 38 species; notable live species are *Cribrobulimina polystoma* (Parker and Jones), *Rosalina irregularis* (Rhumbler) and a spicular test form of *Haplophragmoides pusillus* Collins. There were 37 species of ostracodes present; notable species include *Papillatabairdia elongata* McKenzie, Reyment and Reyment, *Pterygocythereis* sp. aff. *P. velivola* (Brady) and a new species of *Eucythere (Rotundracythere)*. The fauna has some similarities to that found on the Victorian coast. (*The Victorian Naturalist* **116** (6), 1999, 218-227.)

Introduction

Although the foraminiferal fauna of the Victorian coastline is fairly well known, little research has been undertaken on the faunas of Bass Strait or of the surrounds of the Bass Strait Islands. The fossil ostracode faunas of the coastline have recently been the subject of a number of papers (McKenzie *et al.* 1990, 1991, 1993; Neil 1994), but the living faunas have received limited attention (Bell *et al.* 1995; Neil 1993; Yassini and Jones 1995).

The Kent Group (39°29' S, 147°20' E), which consists of three main islands (Deal, Erith and Dover) and two smaller isolated ones (North East and South West Islands), lies approximately halfway between Wilsons Promontory and Flinders Island in Bass Strait (Fig. 1). The group lies on the Bassian Rise in water depths of about 54-64 metres (30-35 fathoms) (Jennings 1959). The immediate seafloor surrounding the islands is mainly barren sand swells but in the more protected areas near the islands there is a rich growth of algae, sponges, ascidians, sea urchins and encrusting and solitary corals (Kuiter 1981; Wiedenmeyer 1989). Some aspects of the history, plants, animal life and general environments of the Kent Group are given by Jones *et al.* (1970), Marginson and Murray-Smith (1969) and Mullet and Murray-Smith (1967).

During late March, 1981, a small expedition of SCUBA divers visited the Kent Group to study the marine fauna (Kuiter 1981). One sample of bottom sediment from 15 metre depth in West Cove, Erith Island, collected by this group, was available for study. It consisted of a fine sand with only a small amount of silt-sized particles and with some algal fragments, broken bryozoa, small gastropods, foraminiferans and ostracodes. The sample had been preserved in 70% alcohol upon collection.

This note deals with the foraminiferans and ostracodes found near Erith Island in the Kent group; responsibility for the various taxa lie with KNB for the foraminiferans and JVN for the ostracoda.

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Results

Foraminiferans

After staining with Rose Bengal (a protoplasmic stain) and washing, a total fauna of 32 species of live foraminiferans and 6 species as dead specimens was found (Table 1, dead species marked *). With the exception of *Carterina spiculotesta* (Carter), the other species have been previously recorded from shallow waters around the Victorian coastline (Apthorpe 1980; Bell and Drury1992; Collins 1974; Parr 1932, 1945). Comparison with Tasmanian coastal faunas is not possible as the Recent Tasmanian faunas have not, as yet, been studied although the faunas from Port Dalrymple and the River Tamar are similar to those of the Victorian coast (Bell 1996).

As species descriptions and illustrations can be found in the above cited references, and in Albani (1979), only selected species are commented upon here.

Haplophragmoides pusillus Collins, 1974 (Fig. 2A, B).

This species has been previously recorded from Port Phillip Bay (Collins, 1974),

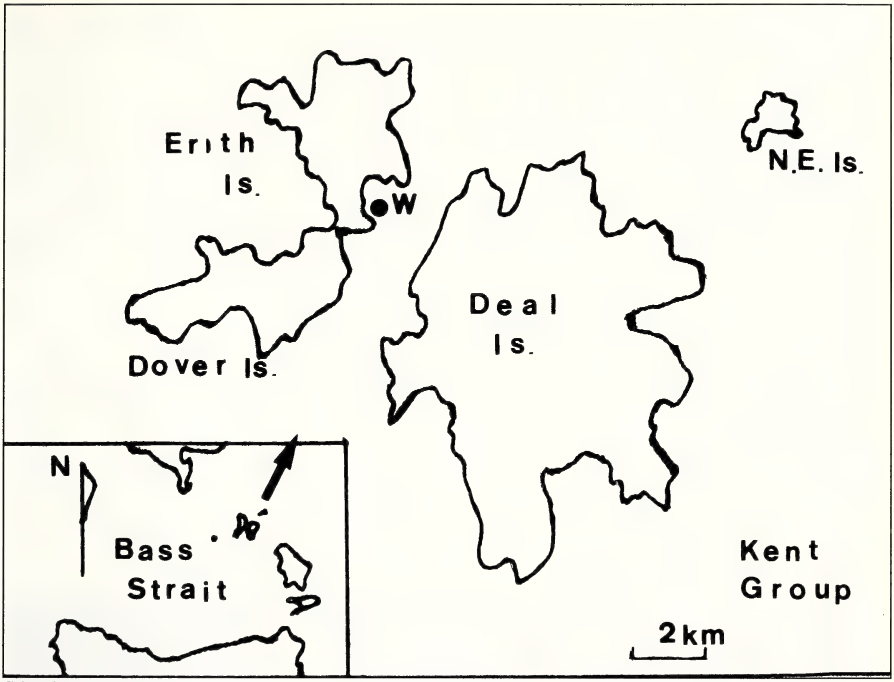

Fig. 1. Locality map showing position of the sample studied (W) from Erith Island.

Mallacoota Inlet (Bell and Drury 1992) in Victoria, and the River Tamar, Tasmania (Bell 1996). The specimens from Erith Island (although similar in size, shape and chamber arrangement to typical specimens from these other localities) differ in wall composition in that the wall is composed of fine quartz grains with various sized needle-like sponge spicules arranged roughly parallel to the coiling direction (Fig. 3B). The test surface is fairly smoothly finished. The difference in wall construction may be a reflection of the large sponge fauna in the area (Wiedenmeyer 1989). This spicular form of *H. pusillus* seems to be identical to that described from shallow water off the Xisha Islands, Guangdong Province, China, by Zheng (1979: 201, pl. 1, figs 10, 11) as *Cribrostomoides spiculotesta*.

Haplophragmoides australensis Albani, 1978.

Rare dead specimens were found in the sample. This species differs from *H. pusillus* in having a coarsely agglutinated test. It has previously only been reported from New South Wales (Albani 1978; Yassini and Jones 1995).

Textularia sp. (Fig. 3F).

Many specimens of a small, ovate, compressed, biserial textulariid were present. In side view the periphery is either smoothly tapered or zigzag due to slightly protruding chambers. It appears to be an undescribed species. This taxon differs from *T. tubulosa* Zheng in not having the overhanging chambers or the domed apertural face of that species (as figured by Loeblich and Tappan (1994)), and they are not as fistulose as *T. horrida* Egger. It is to be described in full in a forthcoming paper on the agglutinated foraminiferan fauna of the Victorian deeper waters.

Siphotextularia sp. cf. *S. mestayeri* Vella, 1957.

Several small (0.3 mm long) but typical specimens of this taxon are described here. The test is compressed, tapering with flat lateral faces and square edges; the walls are finely agglutinated and the aperture is a short slit perpendicular to the final suture. Vella (1957) described the species as having an oblique apertural slit but Loeblich and Tappan (1994) figured specimens from the Sahul Shelf which have a perpendicu-

Table 1. List of foraminiferans found at Erith Island (* indicates species found only as dead specimens); % given as percentage of live foraminiferan fauna; P, indicates presence but percentage < 2%

Haplophragmoides pusilla Collins, 1974	P	*M. labiosa schauinslandi* (Rhumbler, 1906)	P
H. australensis Albani, 1978*		*M. oceanica* (Cushman, 1932)	P
Cribrobulimina polystoma (Parker and Jones, 1865)	15%	*Spirillina vivipara* Ehrenberg, 1843	P
Clavulina multicamerata Chapman ,1909	12%	*Buliminella elegantissima* (d'Orbigny, 1839)	P
Textularia agglutinas d'Orbigny, 1839	P	*Bulimina marginata* d'Orbigny, 1826*	
T. sagittula Defrance, 1824	P	*Bolivina* sp. cf. *B. pseudoplicata* Heron-Allen and Earland, 1930	5%
T. sp.	15%	*Brizalina cacozela* (Vella, 1957)	P
Siphotextularia sp. cf. *S. mestayeri* Vella, 1957	P	*Rugobolivinella pendens* (Collins 1974)*	
Gaudryina convexa(Karrer, 1865)	P	*Elphidium macellum* (Fitchel and Moll, 1798)	6%
Trochammina sorosa Parr, 1950	P	*Planulina bassensis* Collins, 1974	5%
Tritaxis sp.	P	*Patellinella inconspicua* (Brady, 1884)	P
Spiroloculina antillarum d'Orbigny, 1826*		*Glabratella patelliformis* (Brady, 1884)	P
Quinqueloculina moynensis Collins, 1953	P	*Lamellodiscorbis dimidiatus* (Jones and Parker, 1862)	P
Q. poeyanum victoriensis Collins, 1974	3%	*Rosalina anglica* (Cushman, 1931)	3%
Q. subpolygona Parr, 1945	P	*R. irregularis* (Rhumbler, 1906)	5%
Triloculina oblonga (Montagu, 1803)	P	*Cymbaloporetta bradyi* Cushman 1915*	
T. sabulosa Collins, 1974	P	*Acervulina inhaerens* Schultze, 1854	P
T. trigonula Lamarck, 1804	7%	*Cibicidella variabilis* (d'Orbigny, 1826)*	
Miliolinella australis Parr, 1932	8%	*Carterina spiculotesta* (Carter, 1877)*	

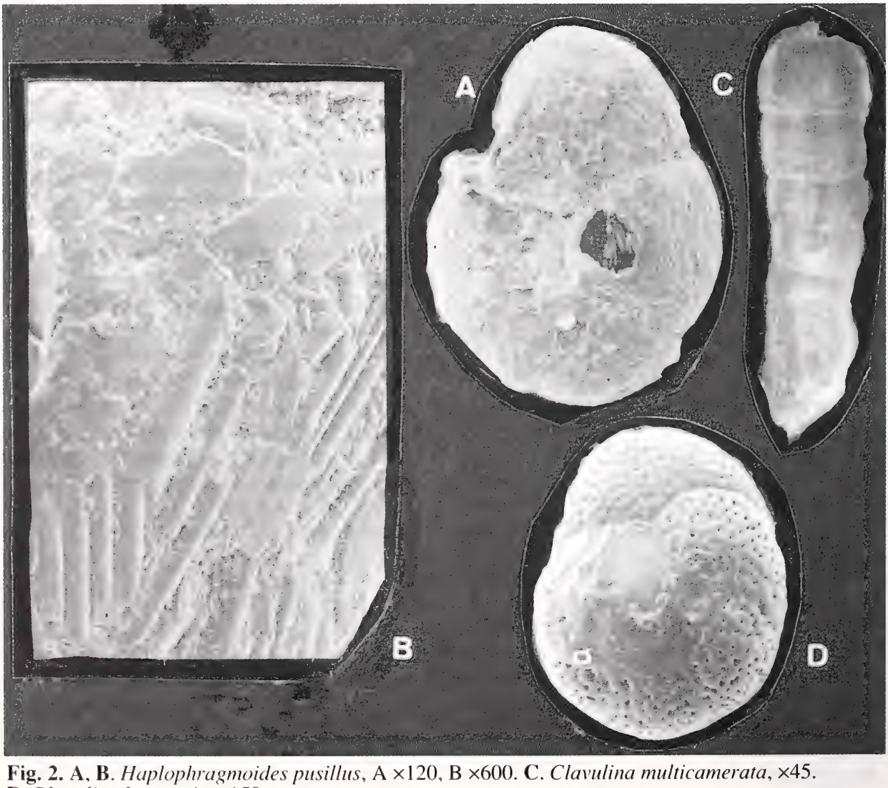

Fig. 2. A, B. *Haplophragmoides pusillus*, A ×120, B ×600. **C**. *Clavulina multicamerata*, ×45. **D**. *Planulina bassensis*, ×150.

lar slit. Until this point is clarified I have not made a definite specific identification.

Trochammina sorosa Parr, 1950 (Fig. 3E).

This species was described by Parr (1950) from off Maria Island, east coast of Tasmania, in depths of 122-155m. Hedley *et al.* (1967) have reported it from the intertidal zone in New Zealand, and it is known from Mallacoota Inlet, Victoria (Bell and Drury 1992). The present specimens are somewhat flattened compared with the more typical conical form.

Cribrobulimina polystoma (Parker and Jones, 1865) (Fig. 3A).

This is a common live species in the fauna, with both the megalospheric and microspheric generation forms present. In many cases the aperture was found to be covered with sand and algal fragments which may represent collapsed feeding cysts. Later chambers may cover all of the earlier test so giving rise to a flattened, subglobular shape.

This species has an interesting distribution: it has not been reported from Victorian shallow waters but is found in shallow waters of Spencer and St. Vincent Gulfs, South Australia, [Cann and Gostin 1985; Cann and Murray-Wallace 1986; Cann *et al.* 1993; who all refer to it as *C. mixta* (Parker and Jones)]; in shore sands at Glenelg and Hardwicke Bay, South Australia (Parr 1932); from sediments of 550 m depth off Cape Nelson, Victoria (Parr 1932); and in the Great Australian Bight (Chapman and Parr 1935) in depths less than 165 m. However, none of these reports distinguish living from dead specimens. *C. polystoma* is also known from the Holocene of northern Spencer Gulf (Cann and Murray-Wallace 1986; as *C. mixta*) and the Pliocene of the Adelaide Plains bore at Cowandilla, South Australia (Howchin 1936). It has also been found in the Upper Pliocene beds at Tailem Bend, South Australia (pers. obs.). Parr (1932) has discussed this species in detail and showed that *mixta* represents the megalospheric generation and *polystoma* the microspheric generation of the same species.

Gaudryina convexa (Karrer, 1865) (Fig. 3B).

A common species in the sample; specimens show quite variable chamber shape and overlap of chambers. This species ranges from the Upper Eocene to Recent in the Australasian region (Burdett *et al.* 1963). The 'Challenger' expedition recorded it from East Moncouer Island, Bass Strait (Brady 1884).

Clavulina multicamerata Chapman, 1909. (Fig. 2C).

This is a common species in the sample and growth stages from just the initial triangular section up to large specimens with nine linear chambers are present. Records of this species are from shallow waters along the Victorian coast and the River Tamar (Chapman 1907; Parr 1932; Collins 1974; Bell 1996).

Miliolinella labiosa var. *schauinslandi* (Rhumbler, 1906).

Rare specimens of this variable growing form of *M. labiosa* occurred. Initially the chambers resemble *M. labiosa* but the later chambers are straight or curved in a series of irregular chambers. It has been recorded from Victorian waters (Parr 1932, 1945).

Miliolinella oceanica (Cushman, 1932) (Fig. 3L).

Typical specimens of this widespread Pacific and Indian Ocean shallow water species were present. Collins (1974) recorded it from Bass Strait and Port Phillip as *Quinqueloculina baragwanathi* Parr 1945, but Ponder (1974) has shown *Q. baragwanathi* to be a synonym of *M. oceanica*.

Quinqueloculina moynensis Collins, 1953.

Rare specimens of this small, quadrate *Quinqueloculina* occurred. It is common in Victorian Bass Strait beach sands (Collins 1974).

Quinqueloculina poeyanum victoriensis Collins, 1974.

This subspecies is characteristic of high energy environments (Collins 1974). It differs from the low energy, sheltered environment form, *Q. poeyanum poeyanum*, in having narrower, straighter chambers and in the narrow aperture with a long, straight tooth.

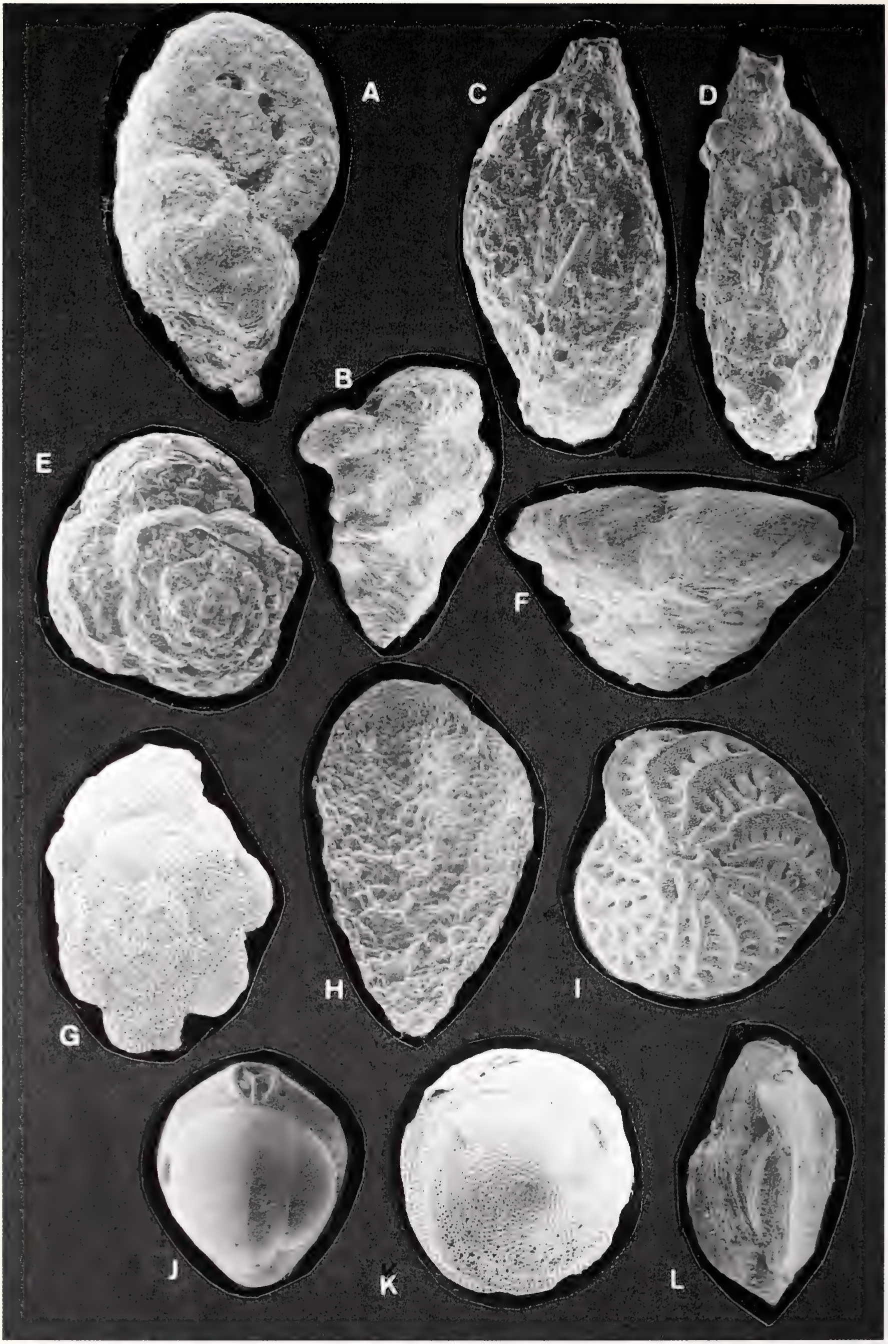

Fig. 3. A. *Cribrobulimina polystoma*, ×45. **B**. *Gaudryina convexa*, ×45. **C, D**. *Triloculina sabulosa*, C ×180; D ×120. **E**. *Trochammina sorosa*, ×180. **F**. *Textularia* sp., ×110. **G**. *Acervulina inhaerens*, ×42 **H**. *Bolivina* sp. cf. *B. pseudoplicata*, ×180. **I**. *Elphidium macellum*, ×90. **J**. *Triloculina trigonula*, ×42. **K**. *Rosalina irregularis*, ×90. **L**. *Miliolinella oceanica*, ×75.

Table 2. List of ostracoda found at Erith Island.

Arcacythere hornibrooki Yassini & Jones, 1995	*Mckenzieartis portjackonensis* (McKenzie, 1967)
Baltraella keiji Yassini & Jones, 1995	*Microcythere dimorpha* Hartmann, 1980
Bythocypris reniformis Brady, 1880	*Munseyella puncata* Yassini & Jones, 1995
Callistocythere bermaguiensis Yassini & Jones, 1995	*Neonesides* spp.
Callistocythere dorsotuberculata Hartmann, 1982	*Orlovibairdia* sp.
Callistocythere hieroglypica Yassini & Jones, 1995	*Papillatabairdia elongata* McKenzie, Reyment & Reyment, 1990
Callistocythere keiji (Hartmann 1978)	*Paradoxostoma crustaecolum* Hartmann, 1980
Callistocythere puri McKenzie, 1967	*Paradoxostoma geraldtonense* Hartmann, 1978
Cypridina sp.	*Paradoxostoma horrocksense* Hartmann, 1978
Cytheretta sp.	*Paradoxostoma schornikovi* Yassini & Jones, 1995
Cytherura sp.	*Paranesidea sinusaquilensis* (Hartmann, 1979)
Eucythere (Rotundracythere) sp. nov.	*Procythereis (Serratocythere) densuireticulata* Hartmann, 1981
Hemicytherura seaholmensis McKenzie, 1967	*Pseudohemicytherideis ornatissima* Yassini & Jones, 1995
Kangarina sp. cf. *K. radiata* Hornibrook, 1952	*Pterygocythereis* sp. aff. *P. velivola* (Brady, 1880)
Keijcyoidea keiji (McKenzie, 1967)	*Semicytherura tenuireticulata* McKenzie, 1967
Leptocythere generodubia (McKenzie, Reyment & Reyment, 1990)	*Tasmanocypris dietmarkeyseri* (Hartmann, 1979)
Loxoconchella pulchra McKenzie, 1967	*Xestoleberis cedunaensis* Hartmann, 1980
Loxoconcha australis Brady, 1880	
Loxoconcha cumulus (Brady, 1880)	
Loxoconcha gilli McKenzie, 1967	

Triloculina sabulosa Collins, 1974 (Figs 3C, D).

The small specimens placed in this taxon are more slender than the typical Port Phillip specimens and also the test usually has fewer larger grains in its construction. The length of the neck is variable which may be an age characteristic.

Rosalina irregularis (Rhumbler, 1906) (Fig. 3K).

The specimens present at Erith Island are very similar to those figured by Rhumbler (1906) and Hedley *et al.* (1967) from the New Zealand intertidal zone, in having normal, regular 1-2 whorls and then irregularly arcuate, flattened chambers with a narrow, thin peripheral rim. The rim is quite fragile and often broken producing a ragged edge to the test. Parr (1945) had specimens, from sands at Barwon Heads, which he referred to *Discorbis globularis* var. *anglica* Cushman but which are very similar to *R. irregularis* from Erith Island..

Rosalina anglica (Cushman, 1931).

The tests are usually deformed by having grown about a stem or leaf of alga or seagrass. As used here *R. anglica* is restricted to specimens which have 1-2 regular whorls and then a series of grossly deformed chambers, usually also slightly inflated. These later chambers are opaque whereas in *R. irregularis* they are transluscent. Parr (1950) has suggested that *R. angelica* is only a growth form of *R. globularis* and should possibly not be separately distinguished. Collins (1974) recorded it from Port Phillip Bay and nearby Bass Strait.

Planulina bassensis Collins, 1974 (Fig. 2D).

This small species is very common in the sample, and is easily identified by its slightly convex/concave shape and evolute whorls; most specimens have a white last chamber with other chambers pale brown. It was originally described from the entrance to Port Phillip Bay (Collins 1974).

Rugobolivinella pendens (Collins, 1974).

Only dead specimens were found in the sample. Originally described from Port Phillip, this species is now known to be widespread along the southern Australian coast, ranging from Eucla, Western Australia, to Port Phillip Bay (Hayward 1990) and from the River Tamar, Tasmania (Bell 1996).

Acervulina inhaerens Schultze, 1854 (Fig. 3G).

This is a common species frequently found attached to seagrass fronds and so shows a variety of shapes.

Bolivina sp. cf. *B. pseudoplicata* Heron-Allen and Earland, 1930 (Fig. 3H).

Although the test surface of the specimens from Erith Island show a randomly reticulate pattern they do not clearly show the characteristic two longitudinal ridges of *B. pseudoplicata*. The figured specimen shows incipient ridges on the final two chambers only.

Carterina spiculotesta (Carter, 1877).

One specimen of this unusual species was recovered but, as internally it only stained a pale pink, was questionably alive when collected. The specimen has only seven chambers. The wall of the chambers show the typical elliptical, parallel arranged, secreted particles, but no evidence of the flat spreading apron as described by Loeblich and Tappan (1955). Previous records are all tropical – subtropical (Loeblich and Tappan 1964). Collins (1958) recorded it from the Great Barrier Reef.

Ostracodes

No distinction between live and dead specimens was possible with the ostracodes in the sample, though the one large specimen of *Cypridina* sp. is stained and includes the soft parts. A total of over 400 specimens was picked. Carapaces and separated valves were counted as individual specimens. Only identifiable broken specimens larger than 50% of a whole valve were counted. The fauna comprised 37 species from a total of 28 genera (Table 2). There was a very high proportion of carapaces (over 75%). Detailed comparisons with faunas from the northern Tasmanian coast and the south-eastern coast of New South Wales are not possible here, but such a comparative study is in preparation.

The fauna is typical of a shallow marine to inner shelf environment, with a few unusual characteristics. The dominant species are *Xestoleberis cedunaenis, Eucythere (Rotundracythere)* sp., *Neonesidea* sp. and *Loxoconcha cumulus*. The species of *Eucythere (Rotundracythere)* is new, and it is unusual to find such large numbers of this genus in a fauna in this region. Other features of the fauna include the variety of paradoxostomatid species; the presence of the species *Pterygocythereis* sp. aff. *P. velivola* which was described from the Gulf of Carpentaria (Yassini *et al.* 1993) and quite a variety of callistocytherids. There are very few cytheropteronids as is characteristic of shallow marine and inner shelf assemblages. On the other hand, there is a complete absence of hemicytherids and trachyleberidids which are often very numerous in fossil faunas from these environments.

A detailed analysis of the ecological implications of the fauna, and a description of the new species of *Eucythere (Rotundracythere)* is being prepared, to accompany the comparisons with assemblages from the beach at Wynyard (Fossil Bluff), Tasmania, and at Twofold Bay, New South Wales.

Papillatabairdia elongata McKenzie, Reyment and Reyment, 1990 (Fig. 4E).

This species is characteristic of an estuarine to inner shelf environment. It was recorded by Hartmann (1978) from a deposit of coral debris in a pool on the reef off Heron Island, Queensland (one specimen) as *Bythocypris* sp., and initially described by McKenzie *et al.* (1990) from the Pleistocene deposits of Goose Lagoon Drain in southwest Victoria. Yassini and Jones (1995) record it from Lake Macquarie and Broken Bay in New South Wales. Its occurrence in the Erith Island fauna suggests its persistence in a cooler environment, in spite of its origin in warmer Pleistocene waters and Recent occurrences in warm temperate and subtropical locations. Only one specimen was found.

Xestoleberis cedunaensis Hartmann, 1980.
This is the most common species in the fauna. It has been recorded by Hartmann (1980); Yassini and Jones (1987, 1995) from saline lakes, lagoons and the intertidal zone. Its abundance in this fauna is somewhat unusual because of the more marine aspect of the assemblage though it may have been transported from the intertidal zone in the Kent Group.

Procythereis (Serratocythere) densuireticulata Hartmann, 1981 (Fig. 4I).

This species is found typically in the intertidal zone of sheltered embayments and the entrance channels of coastal lagoons. Only four specimens were found but this occurrence reinforces the inner shelf signal of the fauna.

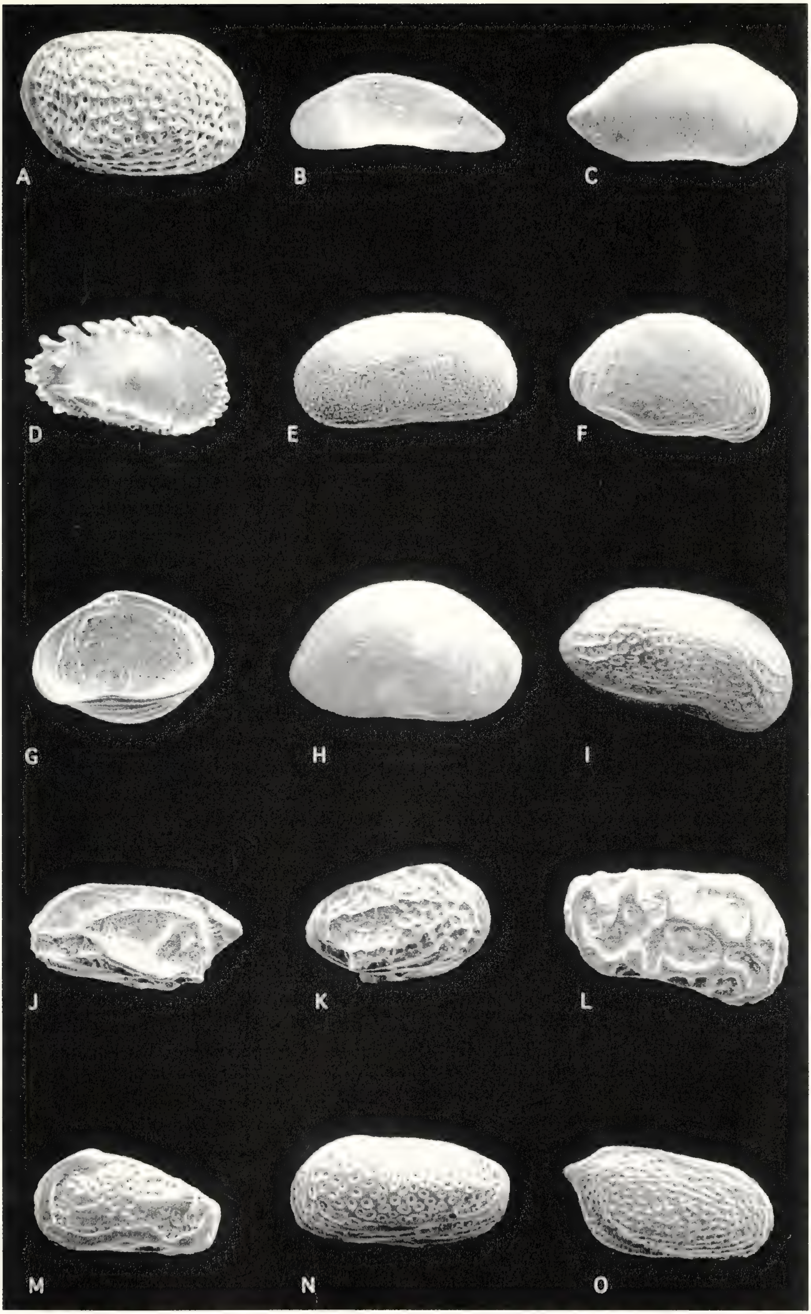

Fig. 4. **A**. *Loxoconcha cumulus*, ×55 **B**. *Tasmanocypris dietmarkeyseri*, ×26 **C**. *Neonesidea* sp., ×33 **D**. *Pterygocythereis* sp. aff. *P. velivola*, ×44 **E**. *Papillatabairdia elongata*, ×44 **F**, **G**. *Eucythere (Rotundracythere)* n. sp., ×66 **H**. *Paranesidea sinusaquilensis*, ×44 **I**. *Procythereis (Serratocythere) densuireticulata*, ×44 **J**. *Semicytherura illerti*, ×66 **K**. *Loxoconcha gilli*, ×55 **L**. *Callistocythere keiji*, ×55 **M**. *Munseyella punctata*, ×66 **N**. *Arcacythere hornibrooki*, ×58 **O**. *Cytherura* sp., ×55.

Eucythere (Rotundracythere) n. sp. (Fig. 4F, G).

The second most abundant species in the fauna, *Rotundracythere* n. sp. differs from the only other Recent species of this genus, *R. bassiana* Yassini and Jones 1995, in being more strongly ornamented and having a more rounded dorsal margin. *R. bassiana* is described as being 'rare in Bass Strait' (Yassini & Jones 1995). Two species of this genus from the Eocene and Oligocene are figured by McKenzie *et al.* (1991, 1993). The presence of the genus usually suggests shallow, open, marine conditions, rather than the intertidal zone favoured by many other species in the assemblage.

Neonesidea spp. (Fig. 4C).

Although there are 25 specimens of this genus in the fauna, they probably represent more than one species, of which *N. australis* (Chapman 1914) is the most common. The genus is generally representative of shallow, open marine conditions.

Loxoconcha cumulus (Brady, 1880) (Fig. 4A).

Loxoconcha cumulus is the most common of the three species of the genus in the fauna. The others are *L. australis* Brady 1880, and *L. gilli* McKenzie 1967 (Fig. 4K). Of the range of environments favoured by *Loxoconcha* in this region, *L. cumulus* is generally found in estuaries in association with seagrasses. *Loxoconcha gilli*, which favours an open marine environment, and *L. australis*, lagoons, estuaries and the shallow shelf, are both quite rare in this assemblage.

Pterygocythereis sp. aff. *P. velivola* (Brady, 1880) (Fig. 4D).

Only one specimen occurs in this assemblage. It has close affinities with the specimens figured by Yassini *et al.* (1993) from the Gulf of Carpentaria. This genus has not been identified previously in fossil or Recent faunas from southern Australia.

Callistcytherids (four species) form a significant proportion of the assemblage. This genus is generally indicative of shallow marine conditions. The Paradoxostomatids present (four species), although not numerically common, also give a clear indication of this kind of environment.

Discussion

It is not customary to present data from just one sample. However, we feel that the dearth of knowledge of the microfauna of Bass Strait and some of the interesting ostracod and foraminiferan occurrences in this sample from Erith Island warrants reporting.

Although the Victorian shallow marine foraminiferal fauna is fairly well documented that of the Tasmanian side of Bass Strait is almost totally unresearched but with the exception of *C. polystoma*, the other species occur widely in Victorian shallow marine faunas (see references already given); *C. polystoma* has never been reported in Victorian shallow waters nor from Bass Strait so its occurrence is significant. It may be that currents flowing from the Great Australian Bight eastwards (Gibbs et al. 1986; Tomczak 1985) transport specimens from the South Australian Gulfs into Bass Strait and they there find suitable habitats near the Bass Strait Islands (it was not found at East Moncouer Island by the 'Challenger' expedition (Brady 1884)). This point warrants further sampling in the shallow areas about other Bass Strait Islands.

The ostracode fauna is characteristic of a cool-water, shallow marine, or intertidal environment. Most of the commonly occurring species of *Neonesidea* and *Callistocythere* are cosmopolitan and do not reflect narrow environmental constraints. However, *Xestoleberis cedunaensis*, although found in the intertidal zone, favours estuarine or lagoonal conditions and *Procythereis (Serratocythere) densuireticulata* has similar preferences. *Loxoconcha cumulus*, which is common in the assemblage, is another species favouring estuarine conditions in association with seagrasses. This range of conditions suggested by the species of the fauna is consistent with the location of the sample.

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Bizarre Encounters with Wildlife: Observations from Around Wattle Glen

Different animal species using the one nest hollow

Stagwatching a tree with a large tree hollow with obvious scratchings around it, led to the discovery of a couple of possum species using this tree. The tree, which is a large senescing Red Stringybark *Eucalyptus macrorhyncha* was found to be home to a Brushtail Possum (in the hollow described) and a colony of Sugar Gliders in another hollow. This tree is also home to a colony of feral European Honeybees. Regularly watching this tree at dusk, I was surprised to discover that the Brushtail's hollow was used annually by a pair of nesting Kookaburras (I observed this for three consecutive years). Presumably they kick the Brushtail out. This leads to a number of questions. Where does the Brushtail Possum go? Must it find another tree hollow or does it sleep out for the summer? How often do birds, which use tree hollows for nesting, evict arboreal mammals during their breeding season? Is this the Kookaburras' preferred tree hollow or is it an indication of lack of suitable tree hollows in the area? Have any field naturalists observed similar events?

An even more bizarre encounter with a Black Wallaby

While walking in bushland close to home I realised our two knee-high (kind of fox looking) dogs had sneakily followed me. I didn't send them home. They continued on with me into the base of a gully which drains into a dam. It was here that we stimulated some uncharacteristic behaviour in a Black Wallaby. The Black Wallaby rapidly and repeatedly circled us (at a radius of approximately 30 m). It occasionally stopped and took a series of deep breaths (as if smelling the surroundings). My initial thought was that there was a young wallaby around, but I couldn't see it. The Black Wallaby continued this behaviour, giving no indication it was about to stop. In order not to continue the disturbance I decided to leave. While this was happening the dogs showed no interest in the Black Wallaby and continued sniffing around the tussock grasses *Poa labillardieri*. As we left the gully (I took a path which would have been about a 200 m walk up the ridge), the Black Wallaby followed behind. The circling behaviour of the Black Wallaby occurred on two separate occasions and the dogs were with me both times (the wallaby didn't follow us out the second time). I've walked this area many times and never experienced anything like it. Characteristically, as you would know, as soon as these animals are aware of your presence they take off.

So what does this mean? Is this typical behaviour or is this Black Wallaby a nut? Was it the same wallaby on both occasions (I'd suspect so but I couldn't be sure)? Has it had an encounter with dogs before which stimulated this behaviour? After thinking about it for a while I wondered whether the wallaby thought the dogs were foxes. Are foxes a threat to Black Wallabies? I've seen Eastern Grey Kangaroos and foxes within the one area and neither seemed interested in the other. Once again has anyone else had a similar encounter?

I'd be interested in other field naturalists describing their bizarre encounters with wildlife during their wanderings. I have no doubt they would be many and varied.

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Editor's note: Regarding the sharing of nest hollows, it has been reported that Sugar Gliders sometimes share a nest hollow with Galahs (*The Bird Observer*, no. 794, March 1999, p. 9). Thank you to Virgil Hubregtse for pointing this out.

Plant Collecting for the Amateur

by T. Christopher Brayshaw

Publisher: *Royal British Columbia Museum, Canada. ISBN 0-7718-9439-2, 44 pp., paperback.. RRP $12.95.*
Distributed by UniREPS, University of New South Wales, Sydney NSW 2052.

Collecting plants is one of the most enjoyable experiences for any botanist, allowing the opportunity to get outdoors and seek out and examine interesting plants. The book, 'Plant Collecting for the Amateur' by T.C. Brayshaw (1996), provides a very basic yet informative guide on how to get started. It includes some very important aspects about collecting, what to collect, and how and when to collect. It discusses the types of information that should accompany any collection, which is of critical importance if collections are to retain some sort of meaning in the years to come. The chapter on mounting and filing specimens gives some valuable information on ensuring collections are timeless.

Brayshaw provides some good advice on pressing and drying plant specimens, including some wonderful ideas for building your own press and drying racks. It was good to see discussion of how to deal with pressing and drying some of the more tricky plant types, such as succulents and plant materials with large cones or fruits. I was also happy to see treatment on collection of non-vascular plants (mosses, liverworts and lichens), an often neglected area of botanical study. However, I don't recommend pressing lichens as their shape can be an important diagnostic feature. Unfortunately, Brayshaw did not cover fungi and algae (micro or macro) and these two groups can cause difficulty for interested amateurs.

Overall, Brayshaw has written a very readable and informative little book with all the information necessary on how to collect, preserve and file plant specimens for both personal and public herbaria. The only detraction being that the book contains potentially useful information on herbaria to send specimens to for identification, books to aid in identification and references to what is legal/illegal to collect - provided you live in British Columbia! For the Victorian naturalist, this aspect of the book is of limited practical value and perhaps relegates the book to the category of 'a really good book to borrow from the library'.

Out of interest, the Melbourne Herbarium generally charges $10 for each identification, and reserves the right to charge by the hour for particularly difficult specimens. Collectors should also remember that, in Victoria, permits are required to remove any plant material from national parks and state forests, which limits the range of material that may be available for collection.

Many plants are rare or threatened in Australia due to reductions in habitat. Some rare plants turn up in some very unexpected places, and, indeed, in many cases it has been the amateur collector that has drawn attention to these populations. However, for particularly interesting plants with limited distribution, the potential for viable populations to be 'collected out of existence' can be a real threat. I would question the need to collect apparently rare or non-abundant plants from an area, especially where the identity of the plant is unknown. Amateur collectors, being curious, yet eternally fond of our native bushland, should be able to find plenty of enjoyment in collecting and identifying the plants that appear numerous and abundant in an area.

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Guidelines for Authors

Submission of all Manuscripts

Authors may submit material in the form of research reports, contributions, naturalist notes, letters to the editor and book reviews. Research reports and contributions must be accompanied by an abstract of not more than 200 words. The ***abstract*** should state the scope of the work, give the principle findings and be complete enough for use by abstracting services. Research reports and contributions will be refereed by external referees. A ***Research Report*** is a succinct and original scientific paper written in the traditional format including abstract, introduction, methods, results and discussion. A ***Contribution*** may consist of reports, comments, observations, survey results, bibliographies or other material relating to natural history. The scope of a contribution is broad and little defined to encourage material on a wide range of topics and in a range of styles. This allows inclusion of material that makes a contribution to our knowledge of natural history but for which the traditional format of scientific papers is not appropriate. ***Naturalist Notes*** are generally short, personal accounts of observations made in the field by anyone with an interest in natural history. These may also include reports on excursions and talks, where appropriate. ***Letters to the Editor*** must be no longer than 500 words. ***Book Reviews*** are usually commissioned, but the editors also welcome enquiries from potential reviewers.

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Abbreviations

Italics are used for the following abbreviations: *et al.*; *pers. comm.*; *pers. obs.*; *unpubl. data* and *in press* which are cited in the text – (R.G. Brown 1994 *pers. comm.* 3 May). Note that 'ssp.' is now 'subsp.'

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All illustrations (including photographs) are considered as figures and will be designed to fit within a page (115 mm) or a column (55 mm) width. Tables must also fit into 55 mm/115 mm. **It is important that the legend is clearly visible at these sizes.** For preference, photographs should be of high quality/high contrast which will reproduce clearly in black-and-white and they may be colour slides, colour or black-and-white prints. Line drawings, maps and graphs may be computer generated or in black Indian Ink on stout white or tracing paper. On the back of each figure, write the figure number and the paper's title in pencil. All figures and tables should be referred to in the text and numbered consecutively. Their captions must be numbered consecutively (Fig. 1, Fig. 2, etc.) and put on a separate page at the end of the manuscript. Tables should be numbered consecutively (Table 1, Table 2, etc) and have an explanatory caption at the top.

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The International System of Units (SI units) should be used for exact measurement of physical quantities.

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Authors are advised to note the layout of headings, tables and illustrations as given in recent issues of the Journal. **Single spaces** are used after full stops, and **single quotation marks** are used throughout (in most cases).

In all papers, at the first reference of a species, please use both the common name and binomial. However, where a lot of species are mentioned, a list (an appendix at the end), with both common and binomial names, may be preferred. Lists must be in taxonomic order using the order in which they appear in the references listed below.

The journal uses capitalised common names for species then the binomial in italics, e.g. Kangaroo Grass *Themeda triandra*.

References

References **in the text** should cite author and year, e.g. Brown (1990), (Brown 1990), (Brown 1990, 1991), (Brown 1995 *unpubl.*), (Brown and Green 1990), (Brown and Green 1990; Blue 1990; Red 1990). If there are more than two authors for a paper use (Brown *et al.* 1990). These should be included under **References**, in alphabetical order, at the end of the text (see below). The use of unpublished data is only accepted if the data is held in a public institution, and the location must be cited in the references. *Pers. obs.* and *pers. comm.* should not be included in the list of references.

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Leigh, J., Boden, R. and Briggs, J. (1984). 'Extinct and Endangered Plants of Australia'. (Macmillan: South Melbourne.)

Lunney, D. (1995). Bush Rat. *In* 'The Mammals of Australia', pp. 651-653. Ed. R. Strahan. (Australian Museum/ Reed New Holland: Sydney.)

Phillips, A. and Watson, R. (1991). *Xanthorrhoea*: Consequences of 'horticultural fashion'. *The Victorian Naturalist* **108**, 130-133.

Smith, A.B. (1995). Flowering plants in north-eastern Victoria. (Unpublished PhD thesis, University of Melbourne.)

Other methods of referencing may be acceptable in manuscripts other than research reports, and the editors should be consulted. For further information on style, write to the editors, or consult the latest *Victorian Naturalist* or 'Style Manual for Authors, Editors and Printers' (5th edition) (Australian Government Publishing Service: Canberra).

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Reptiles and Amphibians – Cogger, H. (1992). 'Reptiles and Amphibians of Australia'. (Reed Books: Chatswood, N.S.W.)

Insects – CSIRO (1991). 'The Insects of Australia: a textbook for students and research workers'. Volumes I and II. (MUP: Melbourne.)

Birds – Christidis, L. and Bowles, W. (1994). 'The Taxonomy and Species of Birds of Australia and its Territories'. Royal Australian Ornithologists Union Monograph 2. (RAOU: Melbourne.)

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